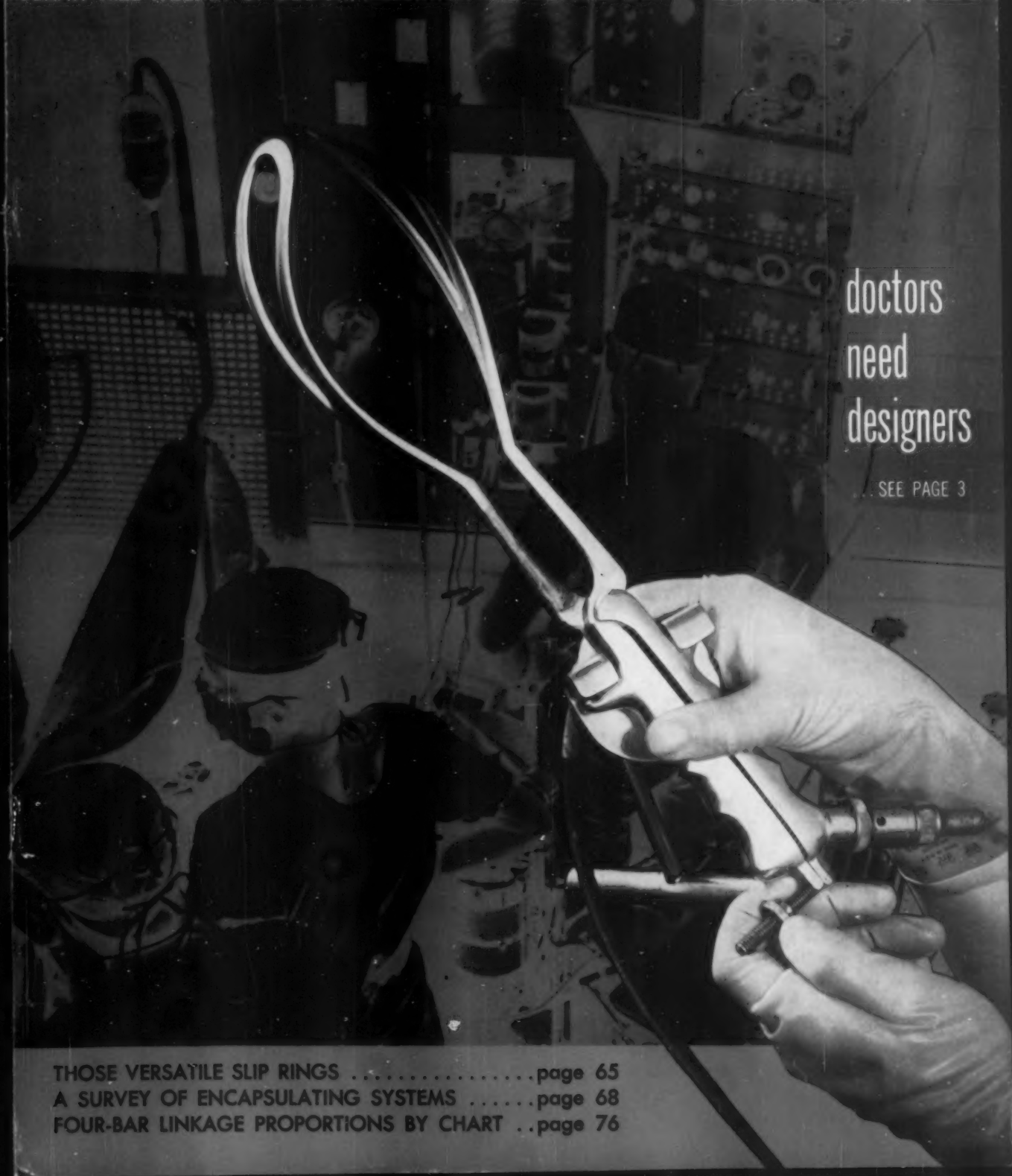
PRICE 50 CENTS

PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT · SEPTEMBER 19, 1960



doctors need designers

. . SEE PAGE 3

THOSE VERSATILE SLIP RINGS . . . . . page 65
A SURVEY OF ENCAPSULATING SYSTEMS . . . . . page 68
FOUR-BAR LINKAGE PROPORTIONS BY CHART . . page 76

NO MATTER WHAT YOU'RE COOKING UP . . . *Chances are there is a ROSS valve ready!*

Ross is the air valve line with the largest selection and latest advancements. Solenoid, hand, foot, cam and air operated valves in both line and base mount models, to serve straightway, 3-way and 4-way functions. Auxiliary and special valves too. Write for digest catalog.

ROSS OPERATING VALVE COMPANY

114 EAST GOLDENGATE AVE. • DETROIT 3, MICHIGAN

PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

September 19, 1960 Vol. 31, No. 39

FEATURED:

THOSE VERSATILE SLIP RINGS . . . G Merker, Electro Tec Corp
Tables point to the best choice of brush-and-ring assembly 65

A SURVEY OF ENCAPSULATING SYSTEMS . . . E A Schatz, Raytheon Co
Up-to-date comparison of basic systems; how to pick them 68

PROPORTIONS OF FOUR-BAR LINKAGES . . . P W Jensen, Remington Rand
Quick and accurate answers are given by this special chart 76

MEDICINE CONSULTS THE DESIGN ENGINEER . . . D K Merris, assistant editor
Special report describes equipment being developed for medics 81

LANCED SHEETMETAL PARTS . . . F Strasser, Mankowitz & Strasser
Followup article gives 10 more applications for economy method 87

DEPARTMENTS:

INTERESTING TO NOTE 3
COMING NEXT WEEK 4
DEVELOPMENTS TO WATCH 6
WHAT'S NEW IN RESEARCH 9
FROM WASHINGTON 12
THE ENGINEERING WEEK 15
POINTS OF VIEW 24
READER TO EDITOR 28
MEETINGS 29
WHY NOT R&D 32
HORIZONS 63
PRODUCT DESIGNS 75
SIGNIFICANT COMPONENTS 90
REPRINTS 113
DESIGN LITERATURE 117
ADVERTISERS INDEX 127
READER SERVICE CARDS 129

FIELDS OF INTEREST REPRESENTED IN DEPARTMENTS:

MATERIALS:
Room-temperature solders stand 100 to 1450 F 6
More price cuts for industrial fibers 8
Added snap for synthetic rubber 10
Fiberglass specifications set up in Canada 17

MECHANICAL:
Rubber magnets coming from Britain 8
Cryogenic units shrink toward practicality 8
Hydraulic nut has dual holding system 8
Sandwich-type strain gage simplifies stress analysis 17
Snap-in, molded grommet cuts sound and vibration while it seals 90

ELECTRICAL:
Czechs claim novel potentiometer for miniaturized systems 6
Bidirectional stepping motor makes 400 steps per second 90

PRODUCT DESIGN:
Bolts stretched for tight fit 75

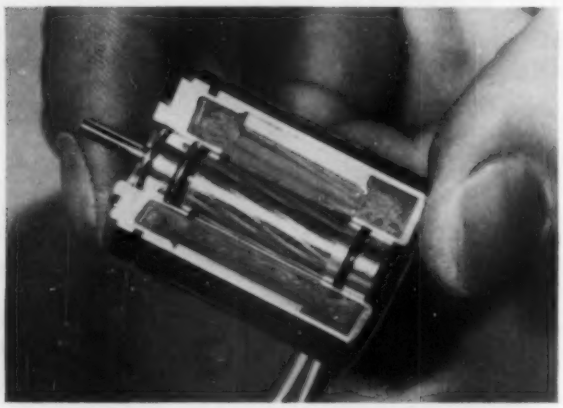
PROCESS:
New route to high-purity resins 10
From powder to product in one explosive step 16

GENERAL:
Designs wanted for passenger-carrying mooncraft 12
US industry building overseas to cash in on expanding markets 15
Comptometer and TelAutograph vie for new market 20

SILICONE NEWS from Dow Corning

How To Get More Drive...

When the heat's on! Engineers for the Harvey Aluminum smelting plant at The Dalles, Oregon, take no chances on the reliability of anode feed motors in the electrolytic cell section. *Ambient temperatures are in the order of 300 F.* Harvey engineers specified Dow Corning silicone insulation for all 960 of the motors. Operated intermittently to adjust the carbon electrode level, these motors have the thermal stability to assure reliability despite the combined heat of high ambient and motor load.



From miniature motors! This servo motor intended for high temperature and humidity service has "sealed in" dependability with Dow Corning silicone insulation. Engineers at G-M Laboratories, Inc., Chicago, specify that the stator coils of this unit will be vacuum impregnated with Dow Corning solventless silicone resin and cured in an inert atmosphere. The cutaway picture shows how the resin completely fills the coil interstices and provides a solid bubble-free mass . . . seals out trouble.

Where the going is rough! Two 20-horsepower, a-c traction motors with Dow Corning silicone insulation keep mine production moving in spite of severe overloads and high temperatures. Goodman Manufacturing Co., Chicago, uses these motors on their four-wheel drive "584" shuttle car to assure the extra overload capacity needed for long life . . . dependable, easy, safe operation. If you need rugged motors for tight spots, specify Dow Corning silicone insulation.

For a reverse twist! On jobs that call for numerous drive reversals, you'll find Dow Corning silicone insulation eliminates frequent motor burn outs. Cadillac Gage of Detroit did. The motors—1-hp, 1800 rpm, Class A insulation—were required to make up to 100 reversals per minute. This created too much heat for the Class A insulation. Since putting silicone insulation to work, Cadillac Gage has not reported a bit of trouble with these lathe motors.

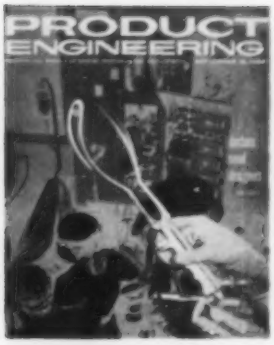
For the complete story on silicone insulated drives, write Dept. 7209.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

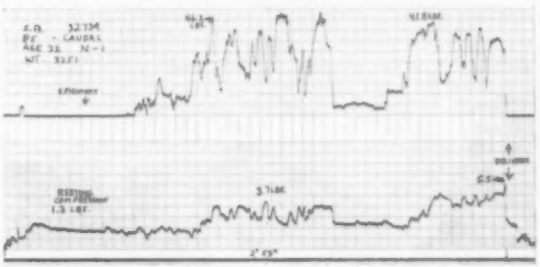
INTERESTING TO NOTE



On our cover—a pair of obstetrical forceps fitted with two strain-gage bridges to tell the doctor precisely how much force he is applying on an unborn child. The forceps—developed by Battelle Memorial Institute for Drs A. R. Fleming, W. H. Pearse and K. Brandenberry—measure, indicate and record tractive effort and cranial compression applied during childbirth. The doctors hope to find the relationship between forces applied at birth and the child's later health.

Design considerations of the forceps included marking in centimeters for depth of insertion, the addition of a clamp to provide the doctor with an adjustable means of pressure control, addition of strain gages suitably encapsulated to withstand sterilizing temperatures, and recording equipment.

The records shown here are actual traces, made during the last 3 minutes of childbirth, with notations by the attending obstetrician. (Weight of the child is in grams—it's a 7-lb 2½-oz baby.) The upper curve is tractive effort; the lower curve is compressive force on the baby's head. Note how the doctor applies tractive effort during the contraction; he releases while the mother rests. The second contraction resulted in delivery. As soon as the infant moved out of the womb, tractive effort went to zero and compressive force dropped sharply.



Patent Injustice

Piracy is not limited to the high seas. For years designers and inventors have seen their ideas exploited by unscrupulous competitors. Patents can protect an inventor just so far. Court litigation is often necessary, and this is expensive and time-consuming. Too often an inventor does not have the resources to help himself. (For some views of a related problem—design copying—see p 24.)

Throughout our history there have been virtually no major inventors who did not end up in court at one time or another trying to protect the products of their mind. All too often the courts have been valueless and the inventor ended in the poorhouse, watching others getting

PRODUCT ENGINEERING

ELMER J TANGERMAN *editor*

STANLEY J ALLING *publisher*

ROBERT W CARSON *managing editor*
RICHARD M KOFF *assistant managing editor*

ROBERT E ABBOTT *senior associate editor*

JOHN KOLB *associate editor*
NICHOLAS CHIRONIS *associate editor*
FORD PARK *associate editor*
ROBERT PRENTISS *associate editor*
ANNESTA R GARDNER *associate editor*
WILLIAM GILMAN *associate editor*
FRANKLIN D YEAPLE *associate editor*
JOSEPH J KELLEHER *associate editor*
DOUGLAS C GREENWOOD *associate editor*

BENEDICT A LEERBURGER, JR *assistant editor*
PHILLIS B SWEED *assistant editor*
DORA K MERRIS *assistant editor*
HERBERT KEE *assistant editor*
CHARLES J LYNCH *assistant editor*

FREDERICK MARICH *assistant editor*
JOHN PRICE *assistant editor*
FRANCIS E HALL *assistant editor*
BRUCE H FRISCH *assistant editor*

FELIX GIORDANO *Detroit*
SETH PAYNE *Washington*

RICHARD E ROOMAN *art director*
E G LOADER *associate art director*
ANGELA M GIACIN *assistant art director*

NORMA J VAN NESS *production supervisor*
LILLIAN M WITHAM *assistant supervisor*

ROBERT E BRUCKNER *consulting editor*
DOUGLAS GREENWALD *director, economics dept*

C C KANE *reader service manager*

McGraw-Hill News Bureaus

JOHN WILHELM *director*
MARGARET RALSTON *assistant*

GEORGE B BRYANT, JR *Washington*
DONALD MacDONALD *Detroit*
ARTHUR ZIMMERMAN *Cleveland*
STEWART W RAMSEY *Chicago*
JENNESS KEENE *San Francisco*
KEMP ANDERSON *Los Angeles*
RAY BLOOMBERG *Seattle*
B E BARNES *Atlanta*
MARVIN REID *Dallas*
JOHN TUNSTALL *London*
ARTHUR ERIKSON *Paris*
GENE DI RAIMONDO *Milan*
RAYMOND SHAH *Zurich*
CURT AGREN *Stockholm*
ERNEST CONINE *Moscow*
JIM MORRISON *Bonn*
SOL SANDERS *Tokyo*
JOHN YAMAGUCHI *Tokyo*

A McGRAW-HILL PUBLICATION

ABP

September 19, 1960
Vol. 31, No. 39

ABC AUDITED PAID CIRCULATION

Executive, Editorial, Circulation and Advertising Offices:
330 West 42nd St., New York 36, N. Y.
Telephone: LOngacre 4-3000
Teletype: TWX NY 1-1636
Cable Address: MCGRAW-HILL, NY

PRODUCT ENGINEERING is published weekly — with an additional Design Digest Issue in Mid-September, by McGraw-Hill Publishing Company, Inc. James H. McGraw (1860-1948), founder. Subscription rates for individuals in the field of the publication, $3 per year, single copies 50 cents; Canadian subscriptions $5 per year; foreign $25 per year, payable in advance. Printed in Albany, NY; second-class postage paid at Albany, NY. Title ® registered at US Patent Office. © Copyright 1960 by McGraw-Hill Publishing Company, Inc. All rights reserved, including the right to reproduce the contents of this publication, either in whole or in part.

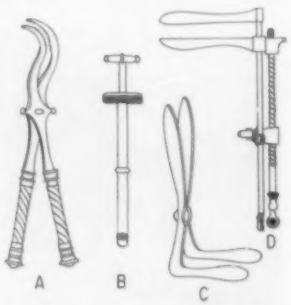
UNCONDITIONAL GUARANTEE. The publisher, on written request, agrees to refund the part of the subscription price applying to the remaining unfilled portion of the subscription if editorial service is unsatisfactory. PRODUCT ENGINEERING articles are indexed in both the Applied Science and Technology Index and the Engineering Index. PRODUCT ENGINEERING publishes its own semi-annual index. Copies are obtainable on request to the editor.
POSTMASTER Please send form 3579 to Fulfillment Manager, **PRODUCT ENGINEERING**, 330 W. 42nd St., New York 36, NY.

rich. Perhaps the worst miscarriage of justice happened to Eli Whitney soon after his invention of the cotton gin. When Whitney developed this machine, which saved the south from economic chaos, he had no difficulty selling his idea. On the contrary, as soon as plantation owners saw the gin turn out more cotton in an hour than several workers could produce in a day, they sowed more seed and pirated Whitney's machine.

Even before Whitney could patent his device, copies were springing up everywhere. Planters, who earned millions of dollars from the idea, were furious when Whitney asked for one pound of cotton out of every three they processed. Some southern states made token payments of $10,000 to Whitney. In all he received about $90,000, which he desperately needed for legal fees. The states that had paid him soon repudiated their agreement and sued to get their money back. (That same year the cotton crop brought in close to $10 million.) Whitney applied to Congress for help and by one vote was saved from this added expense. However, he was left penniless, with only a worthless patent and memories of a useless 10-year struggle through the courts. At the age of 39, Whitney left the South for his home in New Haven Conn, to make his mark in other fields.

Hardware for Healing

For centuries the art of surgery lay in the hands of a chosen few. Secrecy became the key to knowledge and in Egypt any priest-physician who betrayed medical secrets was put to death. (Today we still hear claims that doctors attempt to limit the size of their profession.) Surgery took a big step forward under the Romans about a century before Christ. A primitive anesthesia was developed in the form of soporific sponges impregnated with juices of narcotic herbs. Major operations, amputations and resections of bones and joints were successfully performed. The surgical instruments devised by the Romans maintained their basic design for more than 18 centuries. (The instruments at right were found at Pompeii: (a) forceps, (b) trocar and cannula for tapping fluids confined in cavities, (c) speculum for examining orifices and cavities, and (d) an instrument for dilating wounds for fuller examination—note the interesting application of the screw.)



It wasn't until the 17th century that any real progress occurred in the field of medical instrumentation. The two major developments of the time were the pulse watch and the stethoscope. The making of a 24-hr watch, complete with second hand, presented great mechanical difficulties. Because a physician had need for a more accurate chronometer, an English doctor, Sir John Floger, developed a stop watch to run for just one minute. The first stethoscope consisted of a wooden tube with an earpiece. Despite its simplicity, it gave physicians a much greater understanding of the chest cavity.

The development of anesthesia in surgery during the 19th century opened the doors to a new era in medical instrumentation. Many of the instruments used by today's surgeons date back, in principle, to those of the 1800s. However, as the article on page 81 points out, the surgeon's need for still better, more accurate instruments has presented a challenge to the design engineer.

—Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

. . . High-temperature Electrical Equipment

Motors, solenoids and transformers can be uprated by designing them to run hotter. Here are latest developments in the quest for electrical materials that can stand heat.

. . . Decimal Equivalents of Seconds and Minutes

An aid for stop-watch watchers; 3 handy tables give conversions.

. . . The Machine Tool Show

Every five years the National Machine Tool Builders' Assn sponsors an exhibition in Chicago. PRODUCT ENGINEERING's editors are covering all aspects of the show in a special 15-page report.

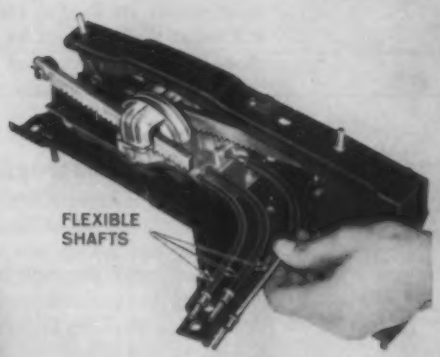
. . . Practical Approach to Friction Coefficients

The author has built a general table of friction coefficients and shows how to modify them to get the values you need.

S. S. White

DRIVE AND CONTROL IDEAS FOR ENGINEERS

HEART OF THE POWER-SEAT MECHANISM... Two slave units, on the left and right sides of seat, are driven by flexible shafts to provide three-way motion. A *single* ¼-hp motor attached to a geared drive unit is the power source. Flexible shafts rotate at 1250 rpm, carry 9 in.-lbs. of torque at running load (three persons) and 15 in.-lbs. at full stall speed.



Flexible Shafts Solve Space Problems in Chrysler Power-Seat

Chrysler Corporation faced a design challenge in its power-operated seat adjuster. Six-way motion was called for: fore and aft, up and down, and tilt. Yet there was limited space under the seat for the mechanism. After much Chrysler testing and development, a design submitted by subcontractor Ferro Stamping Company was approved, utilizing flexible shafts.

According to Chrysler, the decision to go to flexible shafts was based on the following advantages:

1. SPACE ECONOMY..."flexible shafts provided means to transmit power from a single electric motor, without compromising seat design."

2. REDUCED STRESSES..."flexible shafts act as torsion bars to reduce motor armature stresses induced when the mechanism was stopped or stalled suddenly."

3. RELIABILITY..."not a single shaft fatigue failure reported from the field to date."

4. LOW COST..."flexible shafts definitely represented savings without sacrificing design advantages."

Investigate for yourself how flexible shafts can solve many of your design problems and at the same time reduce costs!

S. S. WHITE INDUSTRIAL DIVISION, Dept. 14, 10 East 40th Street, New York 16, N.Y. 1088

THE S. S. WHITE FLEXIBLE SHAFT HANDBOOK
New 4th Edition...Send for your free copy!

This authoritative handbook has been recently revised to include new selection and application data for S. S. White Standard ... Pre-engineered ... Custom-designed flexible shafts.

S. S. White

IN FLEXIBLE SHAFTS

DEVELOPMENTS TO WATCH . . .

Room-temperature solders stand 1000 to 1450 F

Joints that can be made at room temperature but will stand 1450 F are promised by a research program just completed at National Bureau of Standards.

The research was originally aimed at finding new electrical contact materials—and the search was successful. The soldering alloys were a secondary result that now rates further investigation.

The materials are gallium-copper and gallium-gold amalgams, basically similar to dental alloys, to which eutectic amounts (about 8 to 10%) of tin are added. These compositions are fluid at room temperature (their melting point is about 50 F), and will retain their softness for about half an hour after mixing. Then they harden (in about 6 hr) to a form that withstands over 1000 F (for the gallium-gold) and more than 1450 F (for the gallium-copper).

Standards highlight use of fluoroplastics

Proof that TFE fluorocarbon plastics are ready for broad-gage design use is the announcement that the Dept of Commerce is readying commercial commodity standards for TFE electrical tubing, just as it has for automotive tubing, plastic pipe and fittings, and many other common materials and products. The TFE standard will not be published until late next year, most likely; but a list of similar standards already available may be obtained from Commodity Standards Div, Dept of Commerce, Washington 25, DC. It's available without charge. The standards themselves, priced at 5¢ to 15¢, may be obtained from OTS.

Swiss design brushless rotary pickup

Liquid-mercury contacts replace brushes in a new slip-ring design for low-voltage, low-current applications involving transmission of signals from a rotating part to non-rotating leads (dc current from thermocouples, for instance).

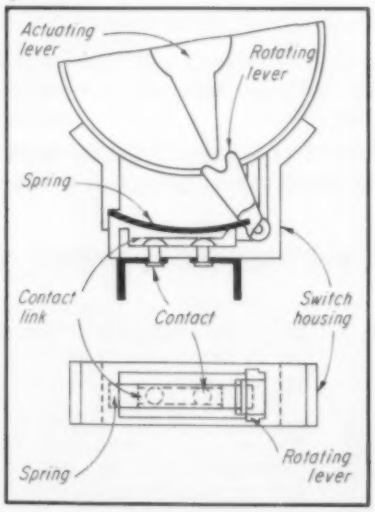
Copper leads clad with a platinum-iridium alloy are immersed in the mercury, which is contained in a small chamber also clad with the platinum-iridium. This helps stabilize contact resistance between rotating and stationary elements and eliminate undesirable thermovoltages. Rubber seals prevent leakage of the mercury.

Detailed information may be obtained from Vibro-Meter Corp, Friborg, Switz.

Czechs claim novel potentiometer for miniaturized systems

A switch that can be mounted radially—on the side rather than the back of small potentiometers—is described in Czech patent No. 92,186.

It consists of a spring, clamped inside the switch housing, and actuated by a lever fastened to the potentiometer spindle. The spring is connected to the contacts by a mechanical link, and is also connected to a rotating lever. As the rotating lever turns in the direction indicated by the arrow, the spring is placed under stress, so that, when the lever passes a certain point, the spring jumps, assuming a convex position (opposite to that shown) and breaking the contact.



NEW SWITCH features a spring, carrying a contact link, to make and break potentiometer connection. Diagram here shows it in the "On" position.

continued, p 8

SEALING LIGHT FLANGES

Lightweight stamped or cast flanges often do not provide uniform compression on gaskets . . . and leaks result. Here's how a simple design change solved this problem and reduced gasket costs as well.

E. M. SMOLEY
Research Physicist
Armstrong Research and Development Center

There is an obvious cost advantage to using a lightweight stamped or cast flange wherever possible. Such flanges can, however, complicate the gasket problem. They usually are not rigid enough to distribute bolt loads evenly on the gasket. As a result, the flanges tend to bend or bow, reducing flange pressure on the gasket between the bolts and permitting leakage.

A typical problem of this type—the cast cover flange of a household gas meter—was recently referred to the Armstrong Research and Development Center. The outline of the flange and the distribution of the bolts are shown in Figure 1. The flange was gasketed with ⅛" material, and flange bowing was suspected as the cause of troublesome leaks in the meter.

To measure the distribution of the bolt load around the flange, engineers used the Armstrong-developed "solder-plug" test. In this test, tiny plugs of solder are placed in holes drilled in the

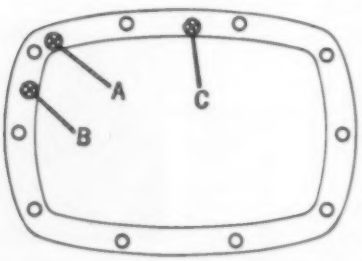


Figure 1. Diagram of the flange gasket indicating bolt spacing. Note bolts are farther apart on the sides than on the ends. Solder plugs were inserted at points A (beside bolt), B (midway between — short span), and C (midway between — long span).

gasket where the degree of gasket compression is to be measured (see Figure 1).

Then the unit is assembled and bolts tightened—flattening the solder plugs. When the flange is opened, the thickness of the flattened plugs reveals exactly how much the gasket was compressed at each test point.

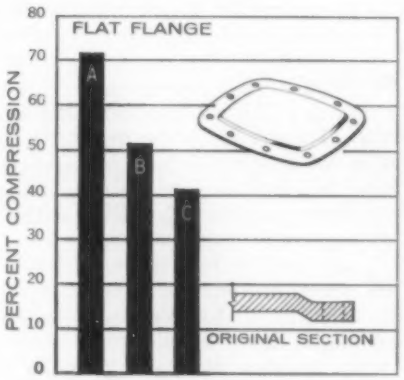


Figure 2. This shows the results of the solder-plug test on the original flange. Outline of the flange and sections is shown at right.

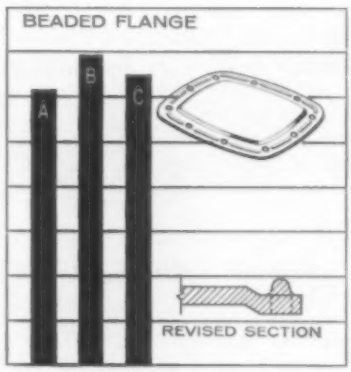


Figure 3. Results of the solder-plug test on the redesigned flange. Note how the bead (see section at right) improved distribution of flange load.

Figure 2 shows the results of this test on the gas meter flange. Note the difference of almost 31% between the minimum and maximum compressions on the gasket. Leakage occurred on this assembly because the flange at point "C" actually did not produce enough load to develop a seal with the gasket material being used.

Armstrong engineers suggested that the manufacturer modify his cover plate to incorporate a rib or bead along the flange between the bolts.

This change required only a minor modification of the forming tool and did not involve any increase in the cost of the finished part. The beads stiffened the flange sufficiently to provide much more uniform distribution of the bolt load.

This was proved by a second solder-plug test, the results of which are shown in Figure 3. With the beaded flange, the maximum variation in gasket compression is only 8.3%.

Not only did the new flange design stop the leaks, but it also allowed a reduction of 50% in the gauge of the gasket. A 1/16" Armstrong cork-and-rubber gasket seals the new flange.

If you have a problem with a lightweight flange, or an application where a lightweight flange could save you money, perhaps our gasket engineering experience can be of help.

We will be glad to make suggestions if you will send details of the application to us. And if you do not already have a copy of the Armstrong Gasket Design Manual, we will be glad to send you one. Write Armstrong Cork Company, Industrial Division, 7109 Irvin Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS
1860-1960 Beginning our second century of progress

continued

Rubber magnets coming from Britain

A new family of flexible magnetic materials is being introduced by Swift Levick & Sons of Sheffield, England. They're ready to offer thin magnetic sheets (to 0.040 in. thick and 40 in. wide), strips, and extruded sections ($\frac{3}{8}$ by $\frac{5}{8}$ in. to 75 ft in length) of neoprene, polyvinyl chloride, and other elastomers incorporating magnetic powders.

These materials are magnetized so they have magnetic poles in the form of stripes or bands, and the company has some novel ideas about where they might be used. A strip of the magnetic material might be incorporated in the sidewall of a bicycle tire, for instance, and magnetized to provide alternating poles. Then, as the wheel turned, and the poles moved around, a current would be generated. Thus the cyclist might provide power for his own lamps.

(Note: For information on new US flexible magnets, see *PE*—July 25, p 6.)

More price cuts for industrial fibers

As predicted (*PE*—Aug 1, p 24), the tire cord battle is bringing new price cuts on almost a weekly basis. Today, nylon is less than $1/lb; rayon less than 50¢. Only a few years ago, nylon was close to $2, heavy-denier rayon well above the half-dollar mark. The cuts should help hold the price line in cord-reinforced mechanical products which still use these fibers rather than the newer synthetics.

Cryogenic units shrink toward practicality

Ultralow-temperature refrigerators that don't take the space of several file cabinets are on the way, says Martin Co.

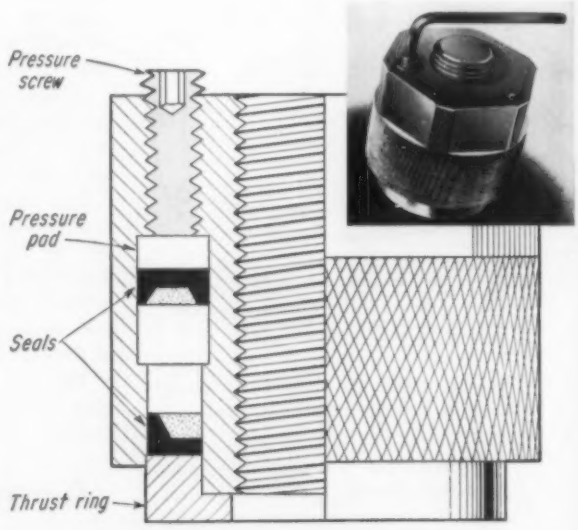
The units will weigh less than 80 lb and develop a 25-watt cooling capacity at 2 degrees K. Furthermore, they'll be closed-cycle "portable" units. Now in the prototype stage, they're expected to pave the way for new, self-sustained heat pump cycles that will permit continuous operation of spaceborne infrared systems and other advanced electronic devices. The new system is said to feature high thermodynamic efficiency and high reliability; involve new expander concepts.

In the prototype, for instance, there is a bell-type expander turbine with a "super-insulated" rotor, mounted on conventional high-precision bearings, so located that they can operate at room temperature. Now, positive-displacement expanders are being developed that "show promise for rather small capacities" (below 10 watts at less than 10 K). These are expected to permit still further miniaturization.

Hydraulic nut has dual holding system

A fastener designed in Britain features a hydraulic, vernier-like tightening system in addition to the conventional screw threads. After the nut has been tightened by hand, an auxiliary screw, fitting in a vertical bore through the nut's wall, acts like a hydraulic piston, exerting pressure through fluid contained in the bore (see diagram).

The designer, Euco Tools Ltd, claims the system achieves unusually high pressures with relatively little effort, and without undue torsional strain. Euco is ready to supply the nut in standard sizes from $\frac{3}{4}$ to 2 inches in 4 thread types. —ARG



FLUID PRESSURE provides extra torque in this "hydraulic" nut designed in Britain. Small screw serves as piston to transmit pressure through fluid contained in recess to thrust ring at base of nut, forcing it against mating surface.

WHAT'S HAPPENING IN RESEARCH . . .

Higher strength for titanium

Zirconium can increase the strength of titanium-vanadium alloys; but finding the best combination is going to take time, says the Bureau of Mines.

In a report just released, the bureau points out that adding zirconium to titanium alloys generally strengthens them. Beneficial effects can be obtained by adding 5 to 20% Zr to alloys containing 5 to 15% V. When the total V-Zr addition exceeds 30%, though, the alloys become hot-short and oxidize readily in air.

Most promising combination found thus far is a titanium alloy containing 10% zirconium and 10% vanadium. The bureau says it "has potential strength and heat-treatability that merits further consideration." This alloy, solution-treated at 1100 F, is quite soft and has a yield strength of 73,000 psi. Aging (4 hr at 840 F) increases the yield strength to 142,900 psi—also decreases ductility. However, metallurgists at the Bureau's Reno station believe adjustments in alloy content and working temperatures may improve this considerably.

New route to high-purity resins

Can the zone-refining techniques, so successful in obtaining high-purity metals and semiconductors, be applied to plastics as well? Tests at the QMC R & E Center and Hughson Chemical indicate they can.

At this month's chemical meetings, J. D. Loconti of QMC and J. W. Cahill of Hughson reported that selective fractionation of organic compounds is possible and that closely related compounds can be separated with relative care.

The process as applied to resins is basically similar to that for metals. A short liquid zone is passed through a relatively long solid charge; and, as the molten zone moves, some fractions move faster than others so that a separation is gradually achieved. In purifying metals, liquefaction is achieved by means of a ring heater which encircles the charge and travels from one end of it to the other. To purify polymers, solvents are used as carriers, and the major portion of the charge is kept solid by cooling. Otherwise, the techniques are the same.

Polystyrene, for example, can be dissolved in benzene and solidified by a mixture of alcohol and dry ice; then liquefied by one or more moving ring heaters. The technique still needs refinement. But Loconti and Cahill believe better results can be achieved with better equipment and predict that zone refining will "yield a finer degree of fractionation than any other method presently available."

More snap for synthetic rubber

General-purpose (SBR) rubber is easier to process and extrude, and shows increased strength and elongation when ultrafine talc is added to the reinforcing carbon black.

Elastic modulus and tear resistance can also be improved in some cases, M. F. Warner of Sierra Talc told last week's ACS meeting.

The explanation: apparently the talc acts as a sort of internal lubricant, allowing the carbon black particles to slip past each other and assisting in their dispersion.

Commercial formulations are being developed to take advantage of the system.

Self-help for radioactive waste disposal

A process by which radioactive waste materials would sinter themselves in dense, leach-resistant compacts that could be disposed of with relative ease has been developed and patented by a group of AEC scientists headed by T. N. McVay.

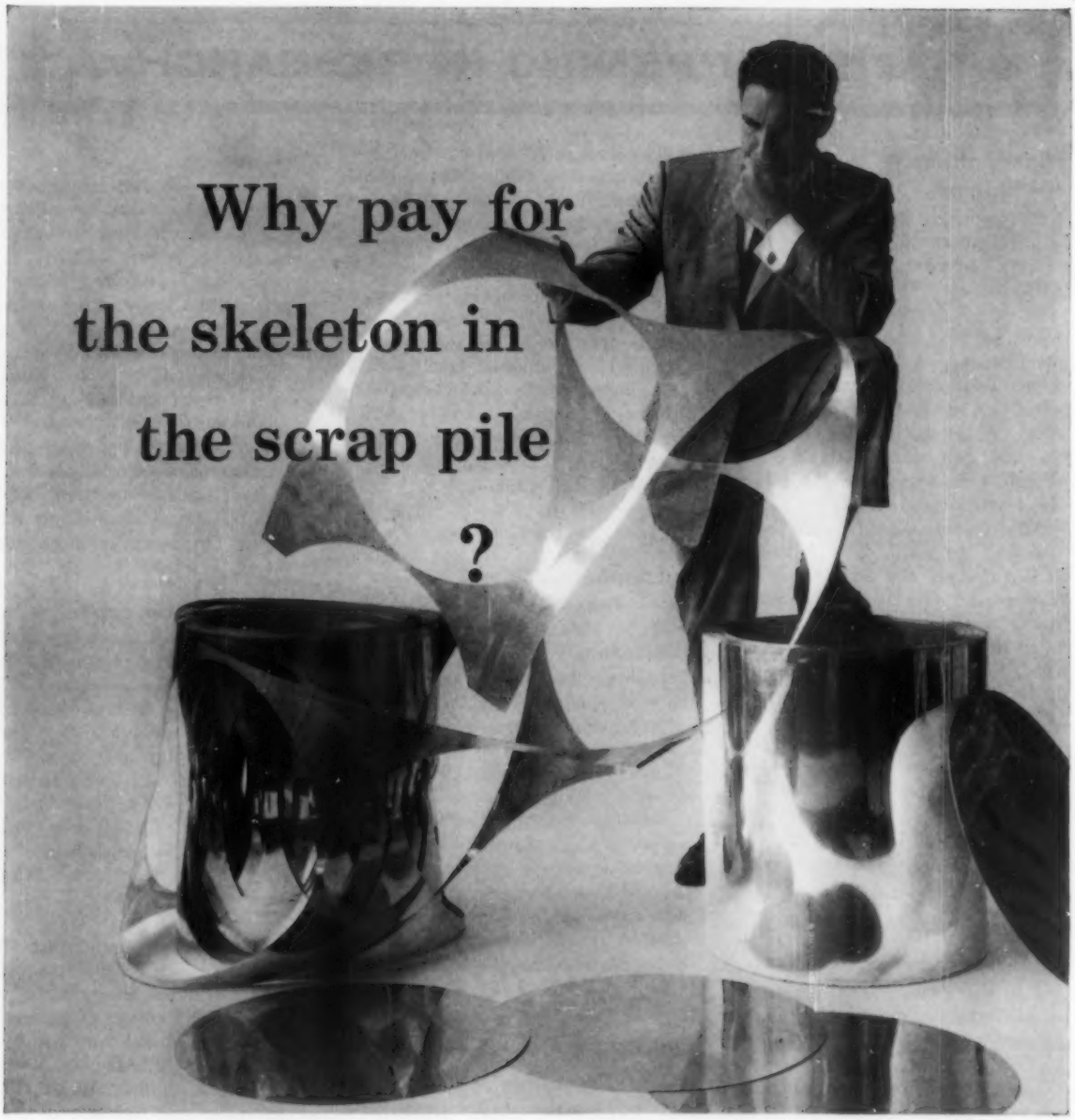
The process is basically simple. The wastes would be mixed with ceramic clays and fluxes to form a slurry or slip which would then be cast into a thermally insulated container. Heat generated by the radioactive materials themselves would bake and dry the slip. Plenty of heat is available. High-level wastes (wastes with a surface radioactivity of 2 roentgens/hr or more) could reach the 1400-F to 1600-F range in 4 to 5 days.

briefs . . .

Improved gear oils and transmission lubricants are promised by Ethyl Corp as it announces development of a new extreme-pressure additive. In gear oils, Ethyl says, the additive "imparts desired load-carrying capacity for protection against gear wear under both high-speed and high-shock loading conditions." And, Ethyl hopes, it "may open the way to a single lubricant for both transmissions and rear axle hypoid gears." The additive, a mixture of chlorinated phosphorus compounds, is now being made available to lubricant formulators for evaluation. Commercial products are not yet on the market.

High-density hafnium carbide is being produced at Lewis Research Center as the first step in a long-range research program aimed at readying this unusually refractory material (melting point: 7030 F) for engineering use. Parts with densities ranging up to 98% of the theoretical limit have been produced by hot-pressing at 3500 psi and 4230 F for 15 min., and standard shapes for mechanical and physical testing are now being produced.

The nuclear elements (and that includes a good slice of the periodic table these days) are being covered in a new series of publications prepared under auspices of the National Research Council. A total of 56 booklets is planned, of which 10 are now in print: The radiochemistry of cadmium, arsenic, francium, thorium, the halogen elements, chromium, rhodium, molybdenum, the alkaline earths, and two transuranium elements. Each booklet provides a background on the chemical reactions of the element or elements under discussion, gives a table of isotopes and a bibliography, and then goes into the radiochemistry in considerable detail. The booklets are reproduced by offset printing, range from 40 to 70 pages in length, and are priced at 50 and 75¢ each, depending on length. They can be purchased individually or on a "subscription" basis from OTS, Dept of Commerce, Washington 25, DC. —ARG



WHEN you stamp your own aluminum circles or any irregular blanks, up to 25% of coil weight ends up as scrap.

You can eliminate this waste—plus labor of shearing and blanking—by buying circles or blanks direct from Fairmont.

Fairmont is *the* source for circles. As a prime supplier of aluminum blanks to *every* utensil maker, Fairmont's 30-year stockpile of dies is unduplicated anywhere. Find out how easily we can fill your requirements from our stock of dies.

Or by blanking from your dies in our plant, we can effect labor, material savings for you.

Other Fairmont benefits: the consistent quality that is a Fairmont tradition . . . individual flash annealing for finer grain structure . . . 100% inspection of every blank.

FIND OUT ABOUT FAIRMONT'S CUSTOM BLANKING SERVICE NOW

A Fairmont engineer will be glad to give you details. Call your local Fairmont office. Or write Vice President, Sales, Dept. 31-I, Fairmont Aluminum Co., Fairmont, West Virginia.

FAIRMONT ALUMINUM COMPANY

subsidiary of

CERRO

DE PASCO CORPORATION

Miniature Soldiers. Army ants carry out intricate maneuvers of wheeling, flanking, and envelopment with faultless precision. Their columns are led by "majors", preceded by "scouts". Raids are conducted by "skirmishers". Between campaigns, they form "bivouacs". Army ants are nature's tiny troopers.

Miniature Ball Resolver, approximately 3⅜" x 2½" O.D. continuously calculates position of aircraft and missiles traveling at supersonic speeds. MPB bearings at critical points keep torque low, and help make possible an accuracy of 0.33 of 1%. This is another man-made miracle in miniaturization.

Man with Miracle. This is Dick Anderson, one of MPB's Sales Engineers, whose cooperation with customers includes expert aid in the application of miniature and instrument bearings. MPB's technical staff, most experienced in its field, can assist you with your own miracles in miniaturization.

Miracles in Miniaturization

ACTUAL SIZE OF THE MPB BEARINGS IN BALL RESOLVER SHOWN ABOVE

Every day man's advances, both on this planet and beyond, are opening new and challenging areas of application for miniature components and mechanisms. And at each step forward, MPB is ready to help with research, engineering and manufacturing facilities unsurpassed in the miniature bearing industry. MPB makes more than 500 types and sizes of bearings ranging from ⅜" O.D. down, meeting requirements of the most exacting nature. Specials developed on request. For a confab on design problems or our latest catalog write Miniature Precision Bearings, Inc., 2010 Precision Park, Keene, N. H.

MPB *Helps you perform miracles in miniaturization*

FROM WASHINGTON . . .

Wanted: designs for passenger-carrying mooncraft

Designers of a 3-man maneuverable spaceship are being sought by the National Aeronautics and Space Administration (NASA). **The vehicle should be able to fly around the moon and back.** NASA has indicated that it may select three different design approaches to the problem and let contracts of around $300,000 each to support them.

The studies, including construction-cost estimates, must be completed by next May 15. Actual construction of the spaceships won't be started for another couple of years or so.

Designers are given a free hand—the only requirements being that the spacecraft must be capable of operating for several weeks in space and be manually controlled by its 3-man crew.

Space experts backing nuclear power

A joint nuclear-propulsion office has been set up by NASA and the Atomic Energy Commission. It is part of NASA's shift in emphasis on nuclear power's role in space exploration.

Back a year or so ago, use of nuclear power in space rockets was downgraded. But the space experts have had a change of heart. They say that nuclear systems can deliver 7 to 10 times as much payload as chemical ones. And for long-range missions—to Venus and Mars for example—nuclear energy is the leading contender in the propulsion field.

Nuclear reactors now under development will be used as upper stages for space rockets—for example, the 1.5-million-lb-thrust cluster of engines known as Project Saturn may get a third-stage nuclear engine. It would enable the rocket to deliver twice the payload of an all-chemical rocket system.

Currently, the AEC is developing three Kiwi-type reactors for space use. Kiwi-A and Kiwi-A prime have already undergone tests at AEC's Nevada test site and Kiwi-A 3 is slated to be tested later this year.

Discoverer catch-plane retrieval capability to double

The Air Force plans to substitute C-130 aircraft as the catch-planes for Project Discoverer soon. Reason for the shift is that the C-130 can retrieve up to 1000-lb payloads, while the C-119 now is use can only recover up to 500 lb.

The C-130 flies faster and higher too. It will allow pilots to start making grab attempts at the parachuted satellite capsule at around 25,000-ft altitudes (the C-119 must wait until the capsule drops to around 15,000 ft before a catch pass can be made).

Crews are being trained now on the C-130 and are expected to take over recovery efforts by the end of the year. The Air Force estimates the more maneuverable C-130 will reduce the number of catch-planes used for returning Discoverer capsules to only about 5 instead of the 10 C-119's at work now.

The Air Force's mid-air catch system also will be used to recover capsules from the Samos reconnaissance satellites when they start operating. Air catches make satellite film available for processing faster than is possible with sea recoveries.

This cylinder for a hydraulic press was cast and machined in a Blaw-Knox Steel Foundry. Weight—231,000 pounds.

Blaw-Knox Steel Foundries have machine capacity to handle the most unusual product requirements

Planing, turning, milling, or boring the most unusually dimensioned casting is no problem in a Blaw-Knox Steel Foundry. There you will find planers up to 15 feet × 15 feet × 36 feet, lathes with an 84 inch swing, and planer type milling machines up to 6 feet × 6 feet × 25 feet. In the same machine shops, you will find the smallest precision tool room equipment.

This huge line-up of tools is part of the basic equipment of each of the five Blaw-Knox Steel Foundries. Because Blaw-Knox is one of the world's leading builders of rolling mills and industrial machinery, its machine shops are equipped to handle all of the operations necessary to finish a steel casting for assembly into the complete unit or sub-assembly.

Machining to exact specifications with a wide variety of tools is another way Blaw-Knox Steel Casting Service adds value to your product. There is no need to ship the rough casting to another location for machining. You have the advantage of a single responsibility from patternmaking to shipping.

If you design or build a product using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like you to have a copy of our brochure detailing Blaw-Knox Steel Casting Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

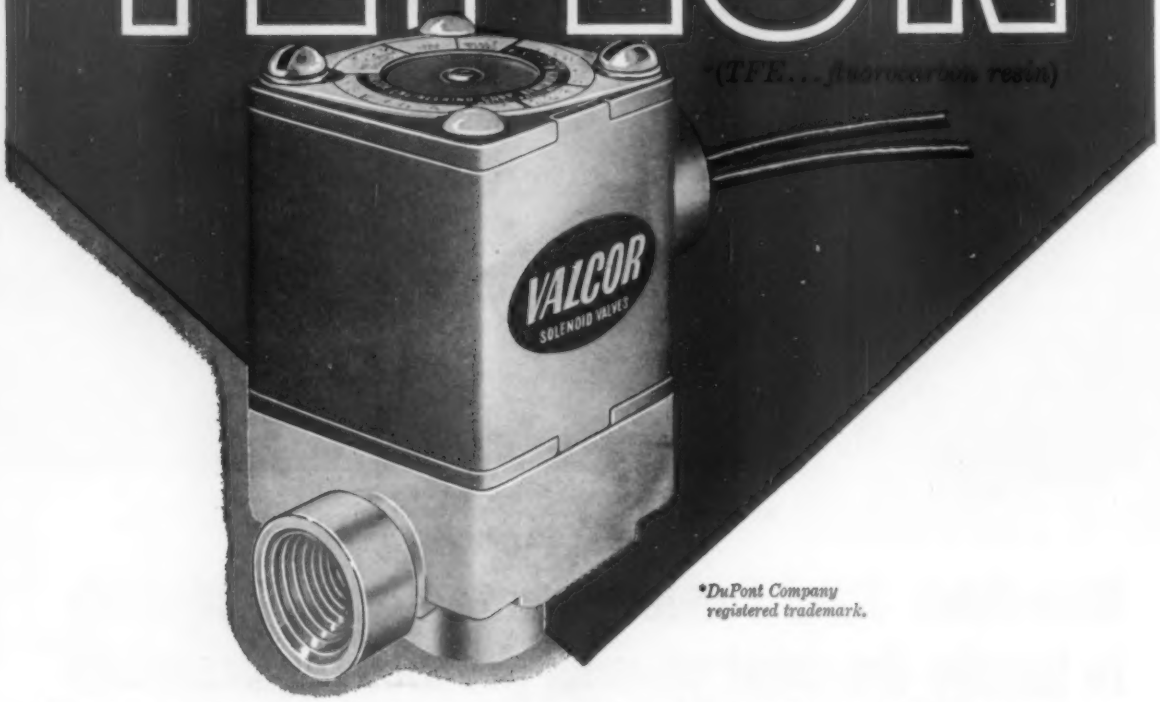
BLAW-KNOX

Steel Castings

CIRCLE 13 ON READER SERVICE CARD

Only VALCOR makes solenoid valves of TEFLON*

*(TFE... fluorocarbon resin)



*DuPont Company registered trademark.

Now, from the company that pioneered the use of Nylon and PVC in solenoid valves for corrosive service, comes a solenoid valve with a **molded body and diaphragm of Teflon** that is **chemically inert and corrosion-resistant to virtually any corrosive medium you are now using.**

Valcor solenoid valves made of all Teflon are ideal for **critically** corrosive applications and where long life is essential. They will outlast and outperform steel. Available in a variety of sizes and pressure ratings. Stocked for immediate delivery. Write today for complete technical data.

SEE OUR EXHIBIT AT BOOTH A801—ISA SHOW

VALCOR SOLENOID VALVES

VALCOR ENGINEERING CORP.

5375 Carnegie Ave., Kenilworth, N. J. • CHestnut 5-1665

US Industry Building Overseas to Cash in on Expanding Markets

Manufacturing companies will spend more than $1 billion on new plant and equipment outside the US this year. They're after new markets, not cheaper labor, they say.

NEW YORK—Migration of US capital to foreign shores for building new manufacturing plant and equipment will run about 20% higher this year than last. A survey by the McGraw-Hill Dept of Economics, covering roughly ¾ of all US companies with foreign investments, shows that manufacturing firms are spending $1127 million abroad this year compared with $935 in 1959. And these firms plan to spend $1304 million next year.

In addition, petroleum companies are continuing to develop their overseas properties, particularly in Latin America. These activities will raise total US investments for this year to $2395 million, a 15% gain over 1959. Next year total investment is expected to hit $2548 million. Petroleum companies are still investing heavily abroad to replace properties lost after Suez, but the peak has apparently passed. If present plans hold, overseas investment by manufacturing companies in 1961 will exceed that of petroleum companies for the first time.

Particularly significant to development of foreign markets is the fact that most money is for building new plant and equipment. Last year only about $70 million was earmarked for purchase of land or existing equipment. About $131 million will go into existing plant this year.

Why They Decide to Add Plants Abroad

(percent of companies answering)

Industry	Higher Profits	Less Competition	Lower Labor Costs	Proximity of Raw Materials	Fewer Trade Barriers	New Markets	Other
Primary Metals*	27	0	0	55	0	18	0
Machinery	3	16	16	0	13	64	0
Electrical Machinery	34	8	0	0	25	25	8
Transport Equip. (incl. autos)	13	7	0	0	20	73	0
Other Metalworking	33	17	0	0	17	50	0
Chemicals	14	9	9	14	38	43	0
Paper	25	12	0	25	0	25	13
Rubber	50	0	0	0	0	75	0
Stone, Clay, Glass	25	50	0	25	0	50	0
Food, Beverages	14	7	0	0	7	71	7
Misc. Mfg (incl. textiles.)	25	8	17	8	33	50	0
Petroleum	45	0	0	64	0	9	18
All Mfg	**20**	**10**	**6**	**13**	**16**	**48**	**3**

Foreign Capital Expenditures by US Companies

(millions of dollars)

Industry	Actual 1959	Planned 1960	Planned 1961
Primary Metals*	104.5	81.5	88.8
Machinery, incl Electrical	249.0	351.1	410.8
Transportation Equipment, incl Autos	215.4	258.5	310.2
Other Metalworking	31.7	25.7	34.7
Chemicals	191.0	246.4	285.8
Paper	31.0	31.0	32.2
Rubber	54.5	56.7	65.8
Stone, Clay & Glass	12.9	17.7	14.5
Food & Beverages	32.9	42.8	43.2
Misc Manufacturing, incl Textiles	11.8	15.1	18.3
All Manufacturing	**934.7**	**1,126.5**	**1,304.3**
Petroleum Industry	1,143.0	1,268.7	1,243.3
Manufacturing & Petroleum	**2,077.7**	**2,395.2**	**2,547.6**

* Includes some mining companies

Note: Dollar figures reflect only expenditures of companies surveyed. These companies account for approximately ¾ of annual overseas expenditures of all US manufacturing and petroleum companies.

LURE OF THE COMMON MARKET

A striking trend uncovered by the survey is the movement of US plants into the Common Market countries. (For a discussion of engineering in this area see PE–Aug 29, p 61). Last year about 17% of US overseas investment found its way into the six nations—France, West Germany, Italy, Belgium, the Netherlands and Luxembourg. This year 24% ($269 million) and next year 27% ($355 million) of US investment will follow.

The survey also found that metalworking companies are especially active in procuring an overseas base of operations. Machinery firms are investing $351 million overseas this year, a 41% gain over last. The companies say that only about $53 million of it will go for purchase of existing facilities. On top of this, transportation-equipment manufacturers are sinking $259 million in overseas plant this year, a gain of 20% over last. About $10 million of this investment will go for existing facilities. About a third of metalworking industry investment is headed for the Common Market, a third for other European countries, and the remainder for Canada, Latin America and the rest of the world

CHEAPER LABOR UNIMPORTANT

Very few of the surveyed companies say that lower labor costs are an important factor in their decision to go abroad. Instead, about half the companies expect to develop new markets. Another 20% see foreign operations as a means of increasing profits. Only 6% say they are going abroad to take advantage of lower labor costs. Many of these firms are concentrated in the machinery industry.

Parent companies are optimistic

over prospects of their foreign offspring. They expect sales this year to spurt 11% ahead of last, and next year to go ahead another 6%. Intensified marketing by subsidiaries is expected to press sales of subsidiaries ahead faster than exports of parent companies. At present, parents foresee a 4% gain in their exports next year, compared with the 6% gain in subsidiary sales.

Especially sharp sales gains by overseas subsidiaries are predicted by these industries: electrical machinery (18% over last year), transportation equipment (15% over last year) and machinery (12% over last year). ■

Space-research Dollars Spread Wider

WASHINGTON—In the first 6 months of 1960, the NASA awarded $134 million in contracts to around 100 companies. Primarily for research, the contracts show how the space business is being spread across the nation.

Here are some examples: Geophysics Corp of America, Boston, received $372,568 to develop instrumentation for determining composition of the upper atmosphere; Grand Central Rocket Co, Redland, Calif, $25,000 for a feasibility study of a "nozzleless rocket"; Plasmadyne Corp, Santa Monica, Calif, $58,000 to study and design an ultraviolet air-density meter; Washington Technology Assoc Inc, Rockville, Md. $97,652 to develop the payload for the Aerobee-100 rocket. ■

Plastics Firms Want Industry-wide R & D

NEW YORK—Some 65% of 285 firms surveyed recently in the plastics industry report that they need an industry-supported research laboratory to solve their research problems (*PE*—Aug 8, p 19).

The survey was conducted by the Plastics Institute Committee, a group probing need for such an institute.

Specifically, 182 companies indicated their need for research. Of these, 147 said their chief interest was in developing new equipment and better processing methods. Some 120 companies said also that their needs involved the development of new polymers and chemical concepts. ■

Metal Powder to Product in One Explosive Step

WEST HANOVER, MASS—Techniques of explosive metal forming are being applied to the field of powder metallurgy in the laboratories of American Potash and Chemical Corp. In this new process powdered metal is actually blasted into shape. Basically the setup includes a die, some powdered metal and an explosive. When the explosive is set off, the pressure forces the powder against the die, giving a speedily formed compact.

The reason for all this is to find a cheaper and easier way to process metals, such as titanium, difficult to work in bar form.

Studies at the company's National Northern Div have been conducted on various metal powders including: titanium alloys, nickel alloys, stainless steel, tool steel, beryllium, molybdenum, uranium, aluminum alloys, tantalum and tungsten. Objective is high-density, high-quality parts with physical properties comparable to or better than those produced in the usual manner, where powder is mechanically compressed, then sintered. To date, densities that are 97% of theoretical (100%) have been achieved.

One problem faced by the engineers was the adverse reaction between some metal powders and the explosive gases. This led to isolating the metal powder from the actual blast and transmitting force through an intermediate medium, such as water.

Damage to tooling is another problem, unless expendable tooling is used, because pressures required for good compacting are in the region that fracture tools. The forming setup must direct and contain forces of the explosion, so the compressive strength of workable tool steel determines the amount of pressure that can be applied. The rate of energy release is approximately 25,000 fps. Total elapsed time for moving metal by explosives is measured in microseconds. In the process, the mechanical properties (including flexural strength, tensile strength, resistance to temperature, malleability, and hardness) undergo a change. These properties are being compared to compacts prepared by conventional techniques. There is also a possibility that the crystal structure of the material changes under these high pressures.

Repeated explosive impacts have produced higher and higher densities on the unit, reports National Northern. There will be a great deal of research into the phenomenon of high pressure short time duration compaction since the physicals of metals, alloys, or compounds change under ultra-high pressures. ■

Variables Don't Daunt This Truck

Teaming a single-stage torque converter with a 5-speed transmission enables this truck to travel at a max speed of 57 mph, climb grades of 60%, maneuver through water of any depth, and operate efficiently in temperatures ranging from −60 to +125 F. The vehicle, developed for the armed forces by Reo Div of White Motor Co, is said to operate on any type of fuel including diesel, kerosene, JP4, gasoline or even lubricating oil. Its 390-cu in. V-8 engine develops 190 hp at 3400 rpm. Variable ratios of the torque converter compound the ratios in the three lower transmission gears, permitting crosscountry operation with less shifting than with a conventional dry clutch.

NEWS FROM CANADIAN TRADE SHOW:

Specifications for Fiberglass on the Way; US Products Are Welcome

TORONTO, ONT—Federal standards for fiberglass-reinforced panels are now being printed and expected to be available by November. They will be called Canadian Government Specification 41-GP-6 for Glass-Fiber-Reinforced Polyester Sheets. This was announced during the recent Canadian National Exhibition sponsored by the city of Toronto.

Commenting on the forthcoming standards, Fraser H. Dewar, manager of technical sales for Graham Products Ltd—makers of this type of panel—said the standards result from a general lack of quality in panels made by small "one-man" companies with ill-equipped plants and lack of technical ability.

Although there are no specific standards for glass-fiber panels in the US, Dewar said he was certain that most panels imported from the US would meet Canadian specifications.

US PRODUCTS WELCOMED

According to J. C. Whitelaw, general manager of the Canadian Manufacturers Assn (CMA), engineering components and materials made in the US are welcomed in Canada despite the vigorous "Buy Canadian" drive. He said Canadians draw a vital distinction between original equipment imports that make and preserve jobs, and consumer products that take jobs.

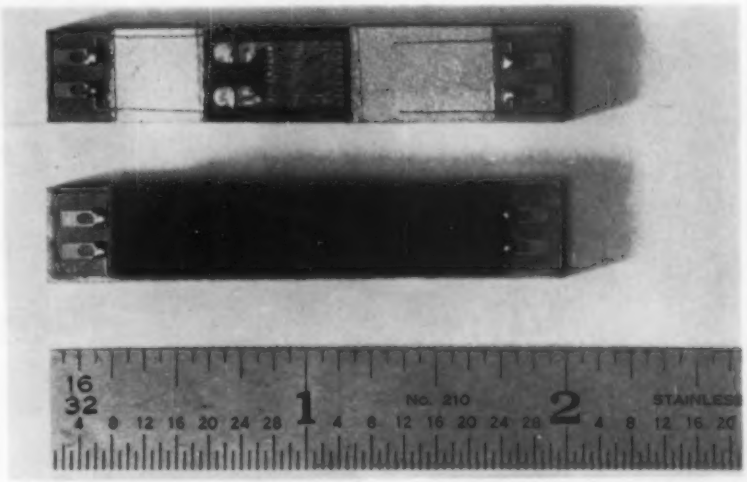
Imports from the US in 1959 were valued at $3,838,000,000—more than four times the total from Britain, West Germany and Japan combined. A high proportion of the US products was industrial and engineering equipment. American exporters of original equipment products, however, should be especially alert to Japanese competition in Canada, a spokesman for CMA said recently.

MUCH MADE IN JAPAN

Many Japanese-made engineering components are starting to invade Canada. But as long as quality and service facilities are maintained by US manufacturers, he said, Canadian buyers will always look to the US for their supplies.

Among Canadian exhibitors interviewed by PRODUCT ENGINEERING, Kenneth Frazer, technical representative for KF Engineering Ltd here, declared that English-French nameplates and instructions are an important but often-overlooked part of design for US products exported to Canada. Consumer-type products were mostly displayed here, although several important US manufacturers with Canadian plants showed components, such as castings, forgings, and gear reducers.

One entirely Canadian-designed product on display was an electrically heated kettle with an automatic control that changes from "fast boil" to "gentle boil" as soon as boiling point is reached. The thermostat can be adjusted for the variation in boiling point with altitude. ■



THE NEW STRAIN GAGE, before and after covering with protective felt. Uncovered unit shows pair of terminals at left connect to top foil of sandwich; leads at right pass through separating plastic layer to other foil. Covered gage is production model.

Sandwich-type Strain Gage Simplifies Stress Analysis

PHOENIXVILLE, PENNA—A new type of strain gage, developed by The Budd Company's Instruments Div, promises to simplify stress analysis. It eliminates conventional back-to-back mounting of individual strain gages for separating bending effects from axial loading. Also called the bending-separator strain gage, the new device (see photo) imbeds two metal-foil gages in a plastic strip—at a precisely controlled distance apart.

This sandwich gage is mounted on the outside of the structure being analyzed, such as a pressure vessel or aircraft wing, and deforms integrally with this structure. Measuring the two strains, one at the top of the plastic block and one at the bottom, allows calculating bending and axial strain components—total strain distribution is linear throughout the sandwich.

The new gage, to be available shortly in three different sizes, was conceived by Dr Felix Zandman—research director of the Instruments Div and developer of the PhotoStress technique of photoelastic analysis. For more details on this gage, read the article coming in the Oct 10 issue of PRODUCT ENGINEERING. ■

Engine Improvements Highlight '61 Citroens, Simcas

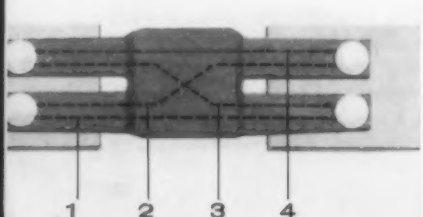
PARIS—Engine improvements feature major design changes in 1961 models of the Simca and the Citroen. However, for all practical purposes, French auto-body styles will remain unchanged.

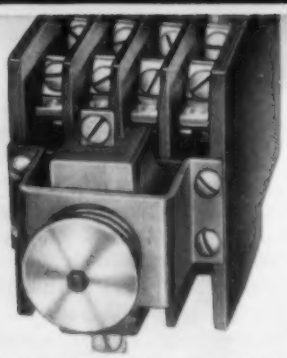
Simca's Aronde and Ariane series sport a new 4-cyl Rush motor, which

continued on page 20

Another Cutler-Hammer first! Up to 24 poles in an area less than the size of a dollar bill.

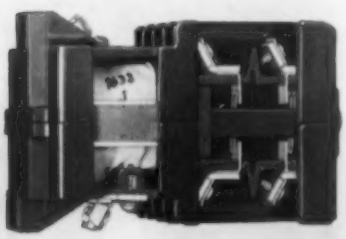
New contact reliability. Parallel bifurcated contacts, which allow four current paths instead of one, provide infinitely greater circuit reliability . . . liberally designed so any current path carries full relay rating.





At last! "Mechanical memory" latch as reliable as the relay itself! No adjustment ever needed. Add latch at any time.

New simplified design! Cutaway view shows basic simplicity. Coil vacuum impregnated to resist damage from humidity, vibration, electrical stress. Terminals can be screw or spade type.



Space savingest relay you've ever seen: New Cutler-Hammer "Compact 300"

Versatile 300 V. control relay is so reliable it's permanently sealed!

Here is the best answer yet to the need for an extremely reliable, small-size 300 V, 6 amp., industrial relay — the new "Compact 300" from Cutler-Hammer.

Every detail known that affects relay reliability has been improved in the "Compact 300." Bifurcated contacts which make possible *four* current paths rather than one, add millions of operations to the "Compact 300's" electrical reliability.

In fact, we're so confident of its electromechanical reliability, we permanently enclose the "Compact 300." And, if it should be damaged by a fault current, you throw it away and replace it with a new one. Its low price makes this an economical, practical maintenance procedure.

Now think of the space you can save with the "Compact 300." It controls up to eight circuits in panel space only 2″ wide by 2¾″ high. 2, 3, 4, 6 and 8 poles with any combination of N.O. or N.C. contacts are available, of course.

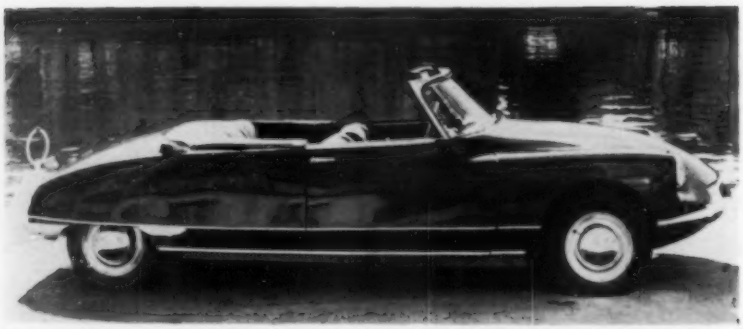
At any time, you can add "mechanical memory" latch with a life equal to the life of the relay. No adjustments are ever necessary. Contact your Cutler-Hammer distributor for details on the "Compact 300" or send for Pub. ED-L079-S249.

What's new at Cutler-Hammer? New, better products, like the 300 V. relay are coming steadily from our new, expanded plant facilities. We're ready now to help you take care of the great industrial growth of the future. If you are planning ahead and need electrical control assistance, contact the nearest Cutler-Hammer sales office.

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.



Citroen is introducing this DS-19, 2-door, 4-passenger convertible among its 1961 models.

has five crankshaft bearings instead of the usual three. This increases crankshaft-bearing surface 30% and reduces bearing spacing 50%, which, in turn, cuts down vibration, permits faster running speeds and higher compression ratio. Result: output for the same 1290-cc capacity as last year's engine has been boosted from 49 hp at 4800 rpm to 52 hp at 4900 rpm with an increase in compression ratio from 6.8 to 7.5 to 1. A "Super" version of the new engine develops 62 hp at 5200 rpm and a heavy-duty version for station wagons and light utility models, 48 hp at 4900 rpm. There is also a 1090-cc Rush engine rated 42 hp at 4900 rpm.

Another feature of the engine is its centrifugal oil filter, mounted on the forward end of the crankshaft. Centrifugal force whirls abrasive particles to the periphery of the filter and the purified oil returns to the motor from the center. Simca claims the filter is two to three times more effective than a conventional filter. The new engine is also equipped with an improved air filter and an automatic spark advance.

Simca gave its new five-bearing engine a serious workout before putting it on the market. Last month an Ariane, powered by the 62-hp Rush Super, wound up an 80-day test run of 124,300 mi at an average speed, including stops for refueling and minor repairs, of better than 62 mph.

Citroen's engine improvement, slated for domestic models of the DS-19 this fall and export models later, eliminates the low-pressure pump previously used to actuate the automatic clutch. In the new arrangement, the clutch-actuating cylinder is connected to the high-pressure hydraulic system through a valve controlled by a centrifugal regulator driven by the motor. The regulator is set so that torque transmission through the clutch is at maximum valve at engine speeds of 1200 rpm and above. At 750 rpm, the clutch is disengaged and up to 1200 rpm, torque transmission increases progressively along with engine output. The clutch-control valve is also linked to a hydraulic cylinder tied into the brake circuit so that a sharp braking effort will disengage the clutch fast.

—Arthur Erikson

Military Offers Civilians Course in Economics

WASHINGTON—A graduate-level correspondence course entitled "The Economics of National Security" is being offered for the 11th year to qualified civilians in business, industry and the professions by the Industrial College of the Armed Forces.

Conducted under the direction of the Joint Chiefs of Staff, the course covers economic and industrial aspects of national security in the context of domestic and world affairs, giving consideration to the interrelated military logistical, administrative, scientific, technolgical, and other factors affecting national security.

Texts and instructional materials are furnished free of charge. The course lasts about 12 months. A college education or equivalent is highly desirable, but not absolutely essential. Interested parties are urged to write for further information to Commandant, Industrial College of the Armed Forces, Washington 25, DC (attention: Correspondence Course Div). ■

Handwriting by Phone: The Two Rivals

NEW YORK—Two telewriters are now competing for a sizable chunk of the communications business. One, made by TelAutograph Corp of Los Angeles, has been around for several years and has some 24,000 units now on lease. Electrowriter, by Comptometer of Chicago, entered the picture in October 1959. Its future is bright at present because it has been approved for use over standard telephone lines. AT&T is now testing a TelAutograph system for similar service.

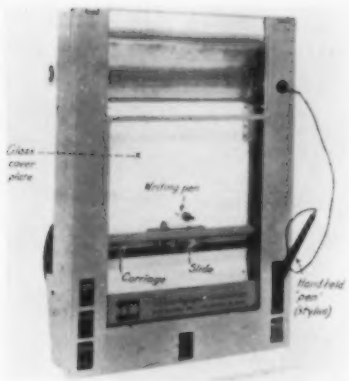
For some time, AT&T traditionally resisted the attachment of any device other than the conventional phone to its lines. Barely two years ago the communications giant began installing digital subsets on public telephone lines—this allowed subscribers to connect electronic devices that remotely process punched accounting cards. Then, last August, AT&T announced it would start installing analog subsets on public lines through which devices such as telescribers can be connected on a toll-call basis. Still more recent is Bell's Data-phone service, now available over public phone lines, which is capable of handling 1200 bits/sec of machine-furnished data.

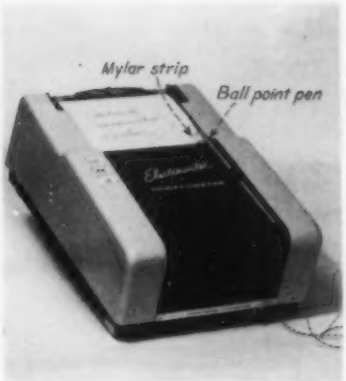
Both types of telewriter transmit handwritten messages and drawings which are accurately and instantaneously reproduced at the receiver.

WHAT IT CONSISTS OF

Comptometer's Electrowriter has three units available; a transmitter, a receiver and a transceiver which can both send and receive. In each sending unit writing is done directly on the paper. Through previous negotiations with AT&T during the Electrowriter's development period, specific audio frequency ranges were assigned so that operation would be compatible with existing telephone facilities. Through this arrangement Electrowriter can operate on standard telephone lines, radio or microwave systems. All it needs is a two-wire circuit and a standard power outlet.

Mechanically it works this way: A ballpoint pen makes the original copy on paper in the transmitter. The pen is connected to a pantograph mechanism by a Mylar strip. Handwriting





motion is separated into X and Y components by the pantograph. Each motion component is transduced into an ac signal in the assigned frequency range. At the receiver, the signal is fed into a filter which separates the X and Y signals. They are then amplified, and converted to dc to drive a pen motor. A pen on the receiver is connected to a pantograph which is identical to that on the transmitter.

TelAutograph produces several units but only one allows the operator to write directly on paper. The earliest model, still used, has the writing appear several inches away from the writing space. In a model designed for desktop mounting, the operator "writes" on a glass plate with the pen following on the paper underneath the glass plate.

TelAutograph's Telescriber mechanism uses proportionating solenoids and pantographic linkages to drive the pen. A motor-driven carriage carries the traversing slide. Power is from electric motors and control is through proportionating slipping clutches on each one end of the motor.

Because Telescriber uses variations in dc potential to transmit, it is now limited to short-range communication; but new systems are under development.

These "missing-links" in business communication have the added feature of low cost. It costs about $45 a month to rent a teletype machine.

A TelAutograph transceiver costs $27.50/mo. However, to operate over regular telephone lines, additional equipment is necessary. Comptometer charges $37.50 for local use of its transceiver; $42.50 for alternate voice-write and long distance writing; for separate-units monthly charge is $35 for the transmitter, $30 for a receiver.

—Bill Wallace, LA News Bureau
—Bruce Cross, Chicago News Bureau

Wescon Show Spans Electronics Field

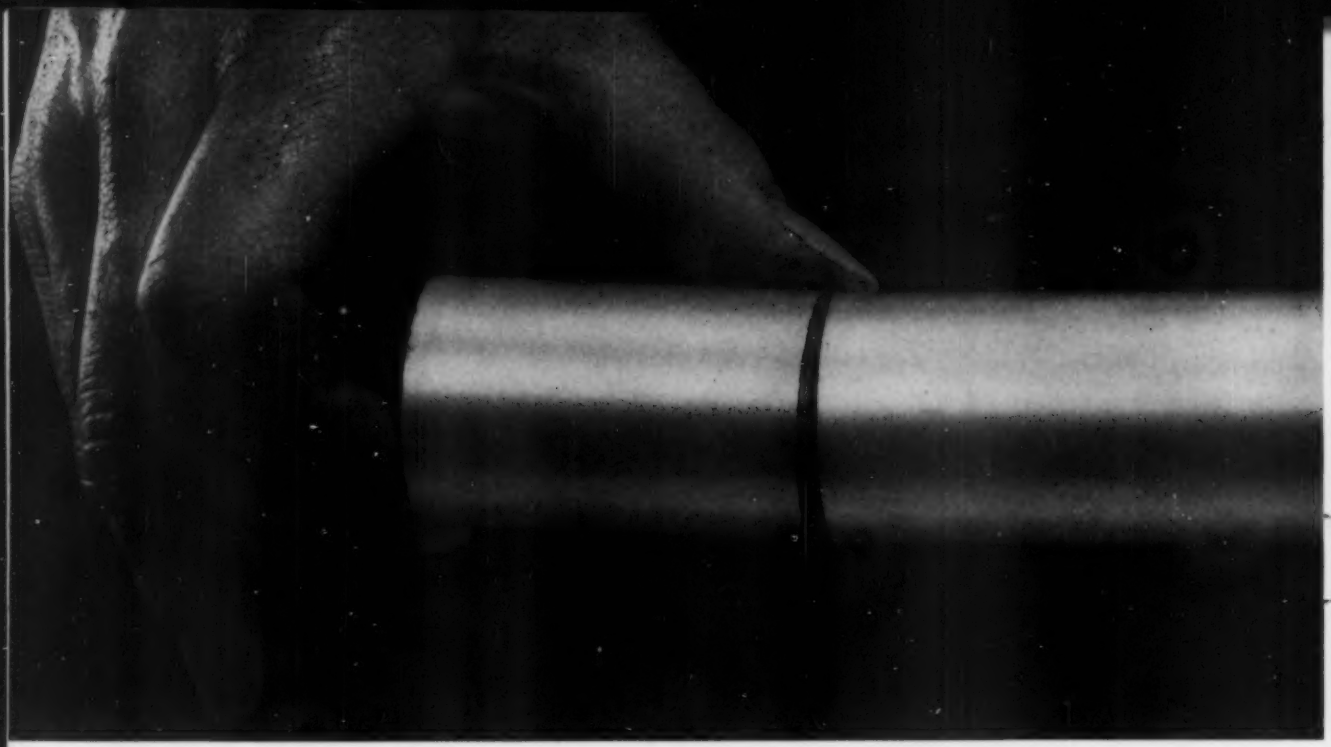
Los Angeles—A total of 987 exhibits of advanced electronic and related space-age equipment were displayed in a near-carnival atmosphere at the recent 10th annual meeting of the Western Electronics Show and Convention. Staged in the Memorial Sports Arena here, the show drew more than 35,000 engineers, scientists, electronics executives and students. Displays ran the gamut from commonplace to exotic, from basic to complex.

A program highlight was competition among 35 science-oriented high-school students who vied for scholarship prizes with working models demonstrating scientific principles they had constructed. These models included: an operational computer, a demonstration of color reproduction using two primary colors instead of three; a satellite-tracking model and other evidences of advanced thinking.

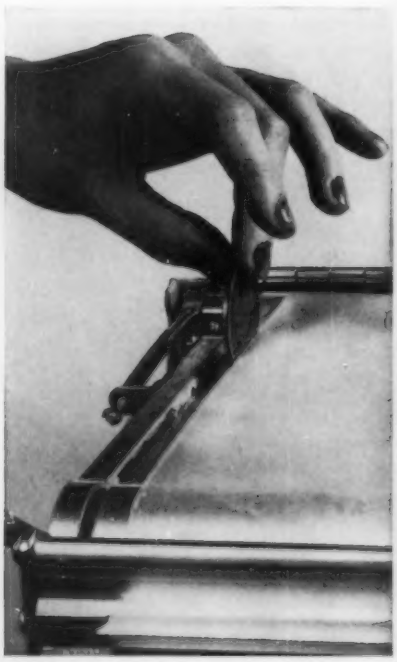
Industry also received honors. Five awards of merit were presented to products of outstanding excellence and 22 other design entries were accorded merit ratings. ■

Modified Drill Press Determines Friction Coefficients

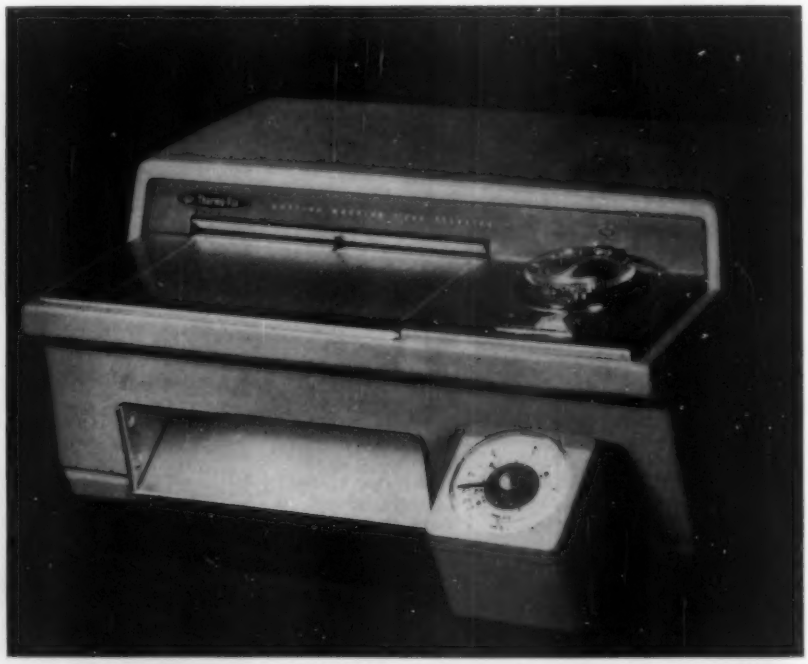
Friction coefficients are, at best, difficult to obtain because many factors must be analyzed. Ernest Rabinowicz of MIT has worked out a practical approach which permits the coefficient to be modified for contaminants, velocity and temperature (see Product Engineering next week for results of this testing—a general table of friction coefficients). The test apparatus, used to investigate the coefficients for broad classes of materials, consists of a hemispherically ended, ¼-in.-dia. rod (A) held stationary with respect to a horizontal, flat-metal plate (B), which is mounted on a steel disk (C). Disk rotates via the electric motor (D), hydraulic variable-speed unit (E) and the pulleys and belts (F). A dead weight (G) loads the slider, and the friction force on the slider causes the flexible shaft (H) to deflect against the strain-gage ring (J). Any change in electrical resistance is amplified and displayed in the Sanborn recording unit (K). Rim of disk (C) has 30-bakelite-filled slots (L) and an insulated contact (N), which records a voltage change as the alternate steel and bakelite strips pass the contact.



Belt alignment assured in



Thickness of a silver dollar indicates the close tracking tolerance of the belt which is 24 inches in circumference.



Thermo-Fax COPYING MACHINES

3M COMPANY

The THERMO-FAX "Secretary" Copying Machine, built by Minnesota Mining & Manufacturing Company using LORIG-ALIGNER Self-Centering Rolls. The terms "Thermo-Fax" and "Secretary" are registered trademarks of the 3M Company, St. Paul 6, Minnesota.

The tilting end sections of the LORIG-ALIGNER roll exert a strong self-centering action that keeps belt in alignment.

"Thermo-Fax" Copying Machines
BRAND

designed with Lorig-Aligner Self-Centering Rolls

This THERMO-FAX "Secretary" Copying Machine has a plastic belt, 24 inches in circumference and 9⅜ inches wide, that must travel in almost perfect alignment for the optimum in reproduction. Early models used complicated tracking mechanisms, including motors and limit switches.

Then by using LORIG-ALIGNER Self-Centering Rolls, designers produced a simplified machine, eliminating a number of costly parts. The belt stays in alignment, sizable savings in manufacturing costs are realized, and greater reliability of service is obtained.

This mark tells you a product is made of modern, dependable Steel.

Where LORIG-ALIGNER Self-Centering Rolls can be used to obtain greater production. On metal strip processing lines, conveyor systems, grinding machines with belts, textile machines, paper-making machines, in fact, any place involving the alignment of a belt or web. Just send the coupon for the complete story.

USS and LORIG-ALIGNER are registered trademarks of United States Steel

United States Steel
Room 2801, 525 William Penn Place
Pittsburgh 30, Pa.

Please send your booklet, "LORIG-ALIGNER Self-Centering Rolls" to:

Name _____

Title _____

Company _____

Address _____

City _____ State _____

(Please Print)

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company
United States Steel

USS

POINTS OF VIEW

THE QUESTION:

How Has Design-copying by

Dr Ernst Leitz
Ernst Leitz GmbH
Wetzlar, West Germany

"We have frequently come across design copying . . . by competitors. It has been noted, however, that most of the design copying is done in such a way that it cannot be spotted immediately by the buyer. This in itself proves that design copying apparently creates a bad impression on the public and imitators therefore try to disguise this fact as far as possible. I should like to point to the more or less slavish design copying of our miniature camera, the Leica, during the last decades. In most cases these imitations came into being and remained on the market only when the manufacturers lived in a country which, for reasons of trade policy or foreign exchange, was closed to our products. In countries where copies have to compete with our products, the copies usually were advertised by big campaigns.

"As far as we can see, the advertising efforts of the design imitators have been more advantageous than detrimental to our sales. There are even certain indications that the advertising campaigns of competitors in countries that are closed to us have stimulated interest in our products to the extent of creating a kind of black market for our cameras. It can be seen clearly from newer products that these imitators have made great efforts to incorporate technical ideas of their own into their instruments in order to gain a better reputation in the eyes of the public. All told, design copying has done little damage to the sales of the original and may even increase its reputation."

"It has helped us . . .
The entry of the Big Three into the compact-car field has served to accelerate the expansion of this segment of the market; it has acted as a stimulus for Rambler sales. Our pioneering efforts in the compact field placed us in a relatively strong position to take advantage of the changing market. The only problem has been in gearing production to increasing demand. In addition, we have a proved product. There is no need for the buyer to become a test driver. Our sales attest to public consciousness of this fact.

"Newcomers to the compact market have further whetted the public's appetite for a more sensible form of personal transportation, thus broadening the potential market of compact-car buyers. Since the beginning of the new model year, we have witnessed some phenomenal changes in the industry. Many previous product concepts have been revised or abandoned as powerful consumer pressure reflected the public's demand for more practical and economical forms of transportation. With few exceptions, the industry is experiencing a vast model shakedown characterized by frequent adjustment of schedule and production facilities to meet rapidly changing market demands."

Roy D Chapin, Jr
Exec vice-president, Automotive Div
American Motors Corp

Competitors Affected the Sales of Your Products?

Bertram Given
President
Waste King Corp

"The overhead costs . . .
are thrown upon the consumer in the form of higher prices. And, in the long run, I feel this practice of design piracy is adversely affecting the total sales of the entire appliance industry. I believe the action on the part of manufacturers to copy others instead of designing their own improvements, has frequently forced the appliance engineering departments of most companies to add quasi-beneficial features in an attempt to improve their competitive position.

"It is reasonable to assume that an increased number of consumers sense and resent this. With a reduced sense of security and respect for any individual manufacturer, and perhaps the community of American manufacturers, the consumer may often purchase only such products as he must, and on a lowest-price basis."

"It has not really affected . . .
the sale of our products. But it takes a lot of creative work and a large dollar investment to maintain our position of leadership. As in the case of other industries, the relatively young and expanding power-mower field has problems of keeping designs advances intact. In fact, the presence of various sizes of companies makes copying the rule rather than the exception.

"We have found that by establishing a solid reputation for product leadership, high quality, and customer service, our products will continue to be sales leaders even though others eventually adopt similar features and designs. A company which leans heavily on others for its product ideas is likely to be lacking in other areas as well. Such a company is not liable to offer very strong competition even though it does adopt successful product designs of others.

"A successful design program becomes firmly established, with good distribution backed up by national advertising. Reputable competition is slower to copy when this 'one-two' punch makes its appearance. The regional manufacturer, without service facilities, without any consistent 'image' for the thoughtful power-mower consumer, has a tougher time convincing prospective buyers that they can stand behind a relatively new improvement.

"About a year ago, we recognized that our wind-tunnel concept was a design hit. We felt (and heard rumors) that there might be a massive attempt to bring out similar models for this 1960 mowing season. To make our position clear, we, in full-page trade advertisements, warned that legal recourse would be taken if its patents were infringed. Thus, despite the advance design position of the company, our management doesn't remain indifferent to potential patent offenders."

Don O Benson
Director, Research and Development
Toro Mfg Corp
Minneapolis

News about R&A SINCE 1913 **Adhesives**

FOR ALL METALS AND ALL PLASTICS

New "room temp" curing epoxy adhesive spreads like cold cream

TECHNICAL DATA ON

Bond*master*® M688

A thixotropic, room temperature curing, 100% reactive, two-component, solvent-free modified epoxy adhesive designed for bonding metals and rigid plastics as well as other rigid materials to themselves and to each other.

APPLICATION

Mixed BONDMASTER M688 is soft and buttery, making it extremely easy to spread smoothly and evenly. Once applied, it maintains its form and DOES NOT FLOW during the curing cycle. Excellent for "poor fit" and similar void-filling applications as well as where dripping or running of adhesive cannot be tolerated.

CURE

Bonded assemblies which have been cured at room temperature can be handled in 4 to 6 hours and develop 85% of their maximum strength in 14 to 24 hours. Alternately, where practical, any of the following heat-cure cycles may be used to achieve full strength more rapidly: 100°F for 2 hours; or 150°F for 30 minutes; or 200°F for 15 minutes; or 250°F for 10 minutes. See Technical Data Sheet for alternate hardeners, pot life, cure cycles, etc.

BOND CHARACTERISTICS

Fully cured bonds exhibit minimal shrinkage, are electrical insulators, and provide excellent resistance to weather, galvanic action, and most chemicals, acids, and alkalies.

R&A SINCE 1913

RUBBER & ASBESTOS
CORPORATION

235 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

Here is why you can save valuable application time as well as material costs with this 100%-reactive, solvent-free epoxy adhesive, BONDMASTER M688:

- Smoothly, easily spreadable with trowel, spatula, knife edge, etc.
- Non-sag (thixotropic) in any position . . . even while curing. Eliminates costly cleanup.
- Cures at room temperature in about 24 hours . . . or in as little as 10 minutes if you can heat to 250°F.
- 100%-reactive . . . no waiting for solvent evaporation . . . mere contact pressure is sufficient.
- Solvent-free . . . no danger of attack on soluble thermoplastics (cells of foamed polystyrene, for example).

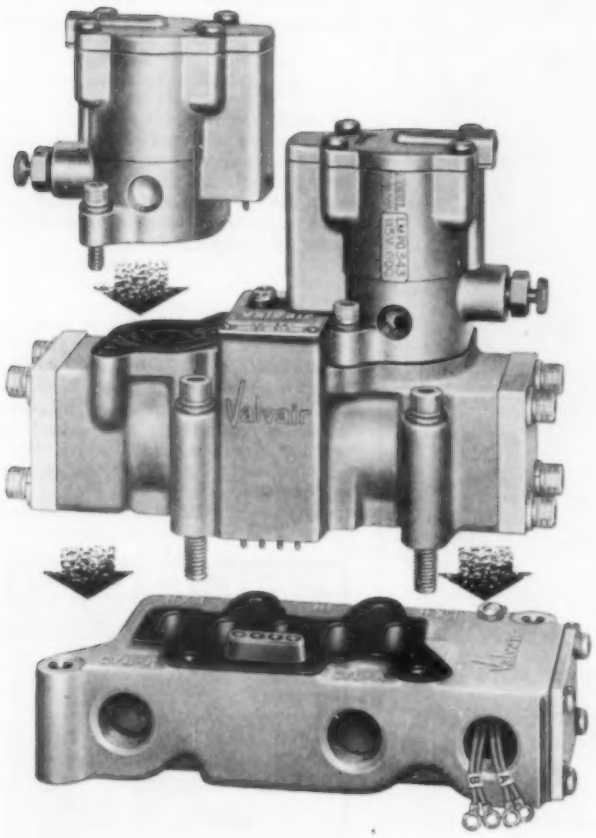
ALL METALS—ALMOST ALL PLASTICS

You'll get strong (in excess of 2,000 psi tensile shear on aluminum-to-aluminum, for example) bonds with cast iron, steel, stainless, magnesium, aluminum, copper, brass, bronze . . . *any* metal . . . to themselves or to just about *any* plastic—rigid, foamed, or flexible.

And, of course, to glass, ceramics, wood, and structural laminates based on reinforced melamine, polyester, phenolic, epoxy, etc., resins.

WRITE FOR FURTHER DATA

Write for detailed Technical Data Sheet today. We'll be glad to send a free sample as well if you will describe your bonding problem in detail.



VALVAIR®
½" NPT
PLUG-IN
VALVES

MODEL PD-441 shown. 4-way single or double pilot-operated types, for sub-base or manifold mounting. Aluminum and stainless steel components assure multi-million cycle dependability. Interchangeable pilots, with coils guaranteed against burn-out for life of valve, fit any plug-in Speed King. Coils for ac or dc, any voltage . . . 35 — 200 psi range . . . integral junction box . . . optional manual over-ride, common or separate exhaust ports, sub-base connected external pilot supply . . . ⅜ in. exhaust ports, ½ or ¾ in. inlet and cylinder ports . . . valve meets JIC standards.

Based on the service-proved design principle of the Speed King ¼ in. plug-in Valvair's ½ - ¾ in. plug-in valve series provides plug-in convenience and versatility to a wider range of control valve applications.

Electrical and pneumatic circuits are completed automatically when valve and pilot are plugged in . . . bolted down. The result — cost-cutting reduction of original installation and maintenance time. All power connections are made permanently in sub-base or manifold . . . there's no need to disturb piping or wiring for quick in-service maintenance.

What's more, advanced design shortens stroke . . . speeds response. Separate coded (4-wire) circuits on double solenoid models meet JIC requirements. Flow area through valve and sub-base equals that of full ½ in. pipe.

Whether your control valve applications are on the drawing board or now in service, it'll pay you to investigate the advantages of Valvair plug-in design. A call to your near-by Valvair field office will bring prompt application engineering recommendations.

For more information, write for Bulletin SPL. Address Dept. PE-960 Bellows-Valvair, Akron 9, Ohio

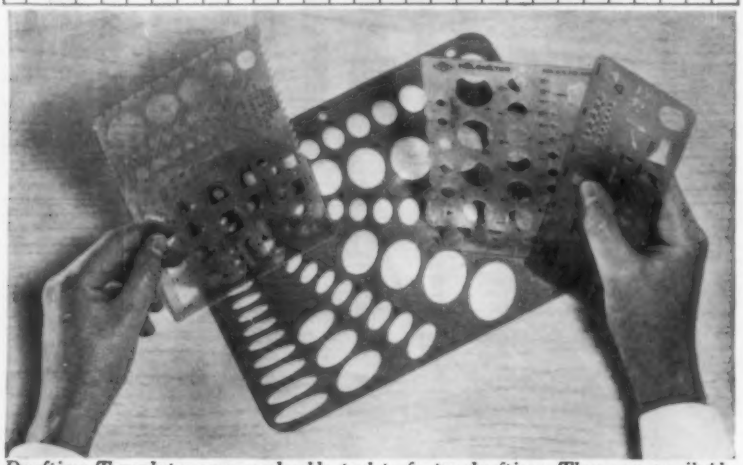
Bellows-Valvair

The Bellows Co. • Valvair Corp. Akron 9, Ohio

DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

8098-3

DRAFTING TRENDS



Drafting Templates are a valuable tool to faster drafting. They are available in an almost endless variety.

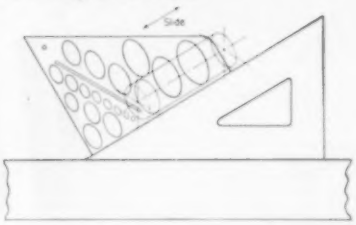
Specialized drafting templates speed drawing time

Always a handy tool, drafting templates are becoming increasingly in use to simplify everyday drawing techniques. Now vinyl plastics are used in the manufacture of the majority of templates. But the thickness, color and finish vary in almost endless profusion. Glare-saving colors, such as green and amber, are usual, both in clear and matte finishes. However, the white and clear plastics still are popular. The thicknesses vary with the different types of available templates from .020 gauge through .070 gauge.

Specialized template applications

A list showing the growing application for templates includes templates for: Electronic Symbols, Electrical Wiring, Landscaping, Screw Heads, House Plans, Nuts and Bolts, Screw Threads, Tooling, Windows, Plumbing, Mathematical Symbols, Map Planning, and many "all-purpose", templates for circles, ellipses, triangles, and other shapes.

Isometric ellipse template is a big timesaver



An isometric ellipse template may be more useful if it is cut in half to provide edges parallel to the minor axes of the ellipses. Halves of the template may then be moved along a 30-60 degree triangle so that ends of a shaft or any cylindrical shape can be drawn in a minimum of time and in perfect alignment.

A selection of 52 popular templates is illustrated and described in a special six page brochure, "Drafting Templates" recently published by Frederick Post Company. *For your copy, write Frederick Post Company, 3642 N. Avondale Ave., Chicago, Illinois.*

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

READER TO EDITOR

Age Query

To the Editor:

The cover of PRODUCT ENGINEERING for July 25 certainly shows a young-looking group of executives. I am personally curious about their ages and have noted my estimates on the enclosed photostat of the cover. How near am I?

—EUGENE C HEACOX
Forestville, Conn

• Mr Heacox's estimates of ages in order from left to right around the picture: 30 to 35, 30 to 35, 32 to 37, 30 to 35, 50 to 55, 57 to 61, 55 to 60, 40 to 45, 40 to 45. We passed this on to Joseph Lewellen, advertising manager of Marchant in Oakland, who made a factual survey. Average age of the group is 42. Six out of the nine are under the average, four of the nine are in their thirties and one is under thirty.—EJT

Engineering Caste System

To the Editor:

Thank you for your recent exposé of today's caste system in engineering and management. Your cover of July 25 illustrates a typical modern American "Engineering Management Team" with members carefully arranged in pecking order. On the left sit four Indians in shirtsleeves. On the right sits the council of chiefs. The four lesser chiefs, toward the rear, are dressed in their identical gray-flannel status symbols. The greatest of the lesser chiefs is readily identifiable by his small, but conspicuous, pocket feather. At the side of the council table, with both hands firmly emplaced, sits the Super Chief attired in full-dress blue-serge paraphernalia, complete with large, ornate pocket feather. In spite of the rigid class distinction and high C/I ratio (Chief-Indian) of this "team," there is, nevertheless, hope for a creative future; for hidden in obscurity among the braves is one lonely little bow (tie) in the four-in-hand patch.

Aside from the obvious humor and

superficiality of this team portrait, its less humorous overtone is the portrayal of a class distinction between design personnel and management personnel. The sharp separation of engineering design from management is inherently incorrect since both are fundamentally planning functions. Draftsmen and design engineers in industry are concerned with product improvement for current sales, with new-product development for future sales, and with efficient manufacturing methods. All of these duties are an extension of management's prime function of planning for profit and growth. The fact that the designer concerns himself with specific planning rather than general planning makes him no less a member of management.

Generally the level of intelligence and education in a design group is considerably higher than average; as a result, there is a tendency toward individual initiative and self-discipline if top management provides any reasonable climate of encouragement, individual recognition and reward for accomplishment. To generate class strata within the broad family of management by degrading design personnel is to divide management against itself. Forces that can yield excellence in engineering are instead perverted, causing deterioration of the working echelons of management and ultimate failure of all management.

—Jack F Rogers
Buckley, Wash
Robert G Sheehan
Bellevue, Wash

COMING EVENTS

SEPTEMBER

21-23 . . . . American Society of Mechanical Engineers jointly with AIEE, National Power Conf, Bellevue-Stratford, Philadelphia

26-28 . . . . Standard Engineers Society, Annual Meeting, Hilton Hotel, Pittsburgh

26-29 . . . . American Welding Society, National Fall Meeting, Hotel Penn-Sheraton, Pittsburgh

27-30 . . . . American Rocket Society, Space Power Systems Conf, Miramar Hotel, Santa Monica, Calif

OCTOBER

5 . . . . Society of Plastics Engineers, Regional Technical Conf, Plastics vs Corrosion, Mark Hopkins Hotel, San Francisco

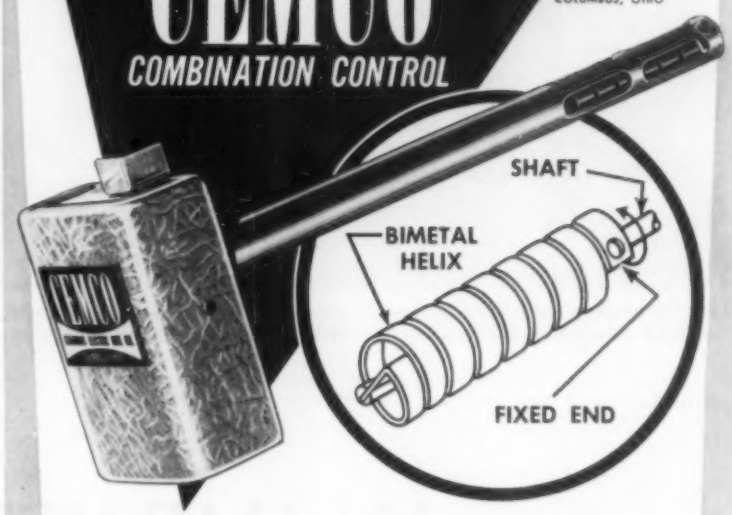
9-11 . . . . American Society of Mechanical Engineers, Rubber and Plastics Conf, Hotel Lawrence, Erie, Penna

10-14 . . . . Society of Automotive Engineers, National Aeronautic Meeting, Ambassador Hotel, Los Angeles

10-15 . . . . Institute of Radio Engineers jointly with ASQC, Reliability training Conf, Texoma Lodge, Kingston, Okla

13-14 . . . . Institute of Radio Engineers, National Symposium on Engineering Writing and Speech, Bismark Hotel, Chicago

Chace THERMOSTATIC BIMETAL
ACTUATES ANOTHER PRECISION PRODUCT...
THE New CEMCO COMBINATION CONTROL
A PRODUCT OF COLUMBUS ELECTRIC MANUFACTURING COMPANY COLUMBUS, OHIO



Warm air, just the right amount; warm air, just the proper temperature—that's what you expect from your automatic heating installation. That's exactly what you get, when the installation includes a new CEMCO Combination Control. The new Combination Controls—model numbers CTC-100-1A and CTC-100 (shown above)—are the results of years of manufacturing and engineering experience and are outstanding performers in their field. Both models are single element helix bimetal type with adjustable fan and limit settings. Model CTC-100 features a summer fan switch, which allows manual fan control in summer. The fan side range is from 80° to 170°; the limit side, 130°-250°. The expected life is 100,000 actuations *minimum!* The helix bimetal actuator is rugged, precision made Chace Thermostatic Bimetal.

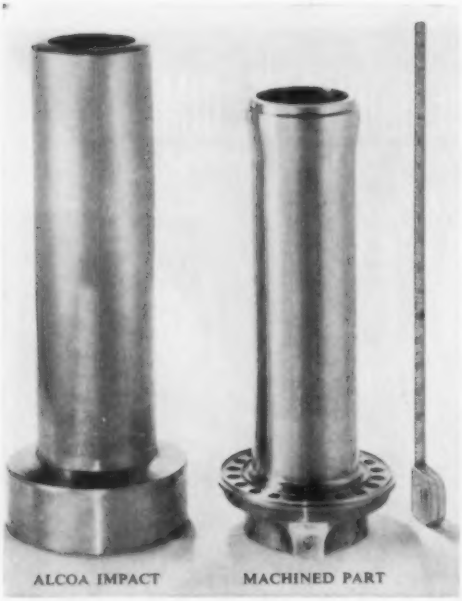
When the manufacturer says, "material, quality and workmanship are not exceeded anywhere in the temperature control industry," he shows extreme confidence in Chace Thermostatic Bimetal. And well he might . . . Chace has been developing and producing precision bimetal and *only precision bimetal* for more than 30 years. Any manufacturer can be sure his valuable name is safe on the outside of his product with Chace Thermostatic Bimetal on the inside.

OUR NEW INFORMATION BOOKLET IS READY NOW!

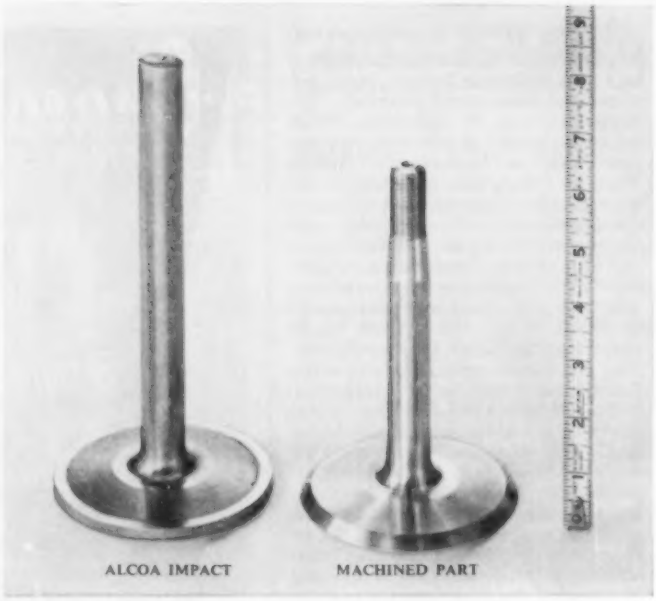
If your new product is approaching the design stage, send for "Information Booklet". It contains design data, illustrations and applications for more than 30 types of Chace Thermostatic Bimetal. Chace bimetal is available in stripes, coils and in completely fabricated elements of your design.

IT BENDS WITH THE HEAT
W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.

CIRCLE 29 ON READER SERVICE CARD



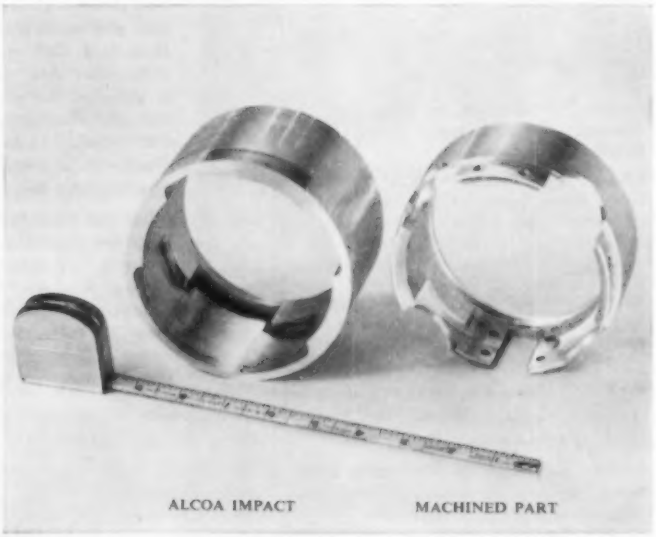
Use of an impact for this missile component provides significant savings in machining time and material cost.



Impact eliminates prohibitive waste of stock previously encountered in machining this air compressor valve from rod stock.

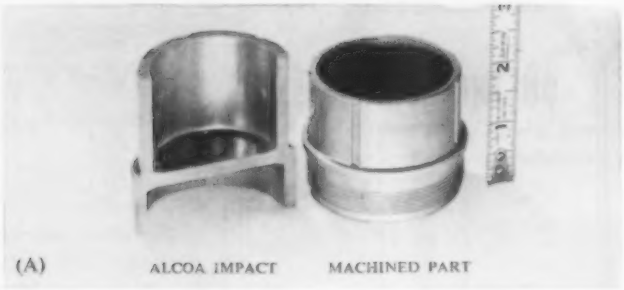
IN IMPACTS . . . Alcoa

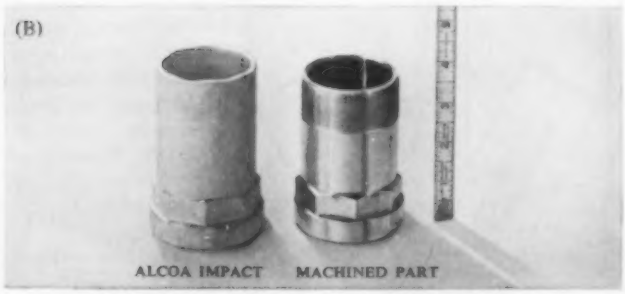
Impact replaces steel forging in which center hole had to be drilled. Cost of finished aluminum part is approximately half that of steel part.



Side-wall steps and grooves in the impact reduce hogging and milling operations in this missile component.

Impact's extremely precise center hole avoids costly deep drilling while impact's outside contour saves high machining chip loss.





(A) Impact incorporates close-tolerance indexing grooves and keys on both ends. Saves precision milling operations and reduces machining time and costs.

(B) Impact reduces machining waste and milling of flats—unavoidable if this sleeve cable connector were machined from heavy wall tubing.

puts the metal where you want it

Impact banishes deep drilling and wasteful machining required when machining this aircraft landing gear plunger from solid stock.

. . . to save time, money and metal in machining blanks

Every impact on this page is produced quick as a wink. Every one is produced in a strong, heat-treatable alloy with good machining characteristics. Every one incorporates a costsaving design feature—a flange, step, groove, keyway, stem, rib, cavity or deep hole. Every one is made to close tolerances—as close as ±0.005 in.—without draft. Every one eliminates excessive machining waste and costly operations such as hogging, milling, broaching or deep drilling. Every one is visible proof that in impacts, Alcoa puts the metal where you want it.

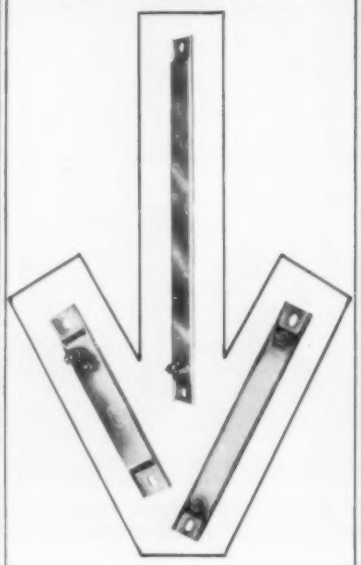
The more you know about impacts, the more uses—and savings—you'll find in your own production. See for yourself. Write for *Metal in Motion*, Alcoa's new 34-page brochure on impacts. Aluminum Company of America, 908-J Alcoa Building, Pittsburgh 19, Pa.

Alcoa puts the metal where you want it—
in castings, forgings, extrusions, screw machine parts and impacts.

ALCOA ALUMINUM

For exciting drama watch ALCOA PRESENTS
every Tuesday evening—ABC-TV

ON THE SURFACE...



YOU CAN'T BEAT
VULCAN STRIP
HEATERS

The surface we mean is *any* flat surface to which Vulcan Strip Heaters can be clamped — dies, platens, molds, etc. Vulcan Strip Heaters are also excellent as air heating sources for ovens, air ducts, dryers, etc. And these versatile heating elements can be formed into circles (one or two-piece) in radius of 5" or more.

Standard one-piece seamless sheaths are made in steel for sheath temperatures to 750°F; Chromalloy to 1200°F. Lengths are from 8" to 42½" (special, shorter or longer). Wattage ratings are from 150 to 1500 (or higher).

Write for catalog and prices.

VULCAN

Versatility in Electric Heating

VULCAN ELECTRIC COMPANY, Danvers, Mass.

WHY DON'T THEY R&D..?

. . . improved sampling machinery for the cotton-processing industry. Much of the cotton processing machinery is basically unchanged from that used 100 years ago. New equipment and techniques are being introduced slowly, but are not quickly accepted–partly because of tradition, mainly because the improved equipment is complicated and costly.

Mechanical samplers, which remove a small portion of cotton for judging quality of the entire bale, were introduced about 5 years ago. They have since been installed in about 150 processing plants in the U. S., mostly in California and Texas. According to a recent survey published by US Department of Agriculture (Marketing Research Report, No. 412, available from USDA, Marketing Economic Research Div, Washington 25, DC) cotton growers and gin operators find that though the new machinery is an improvement, it is not entirely reliable and is too complicated and too expensive to operate.

The new methods extract the sample while the cotton is being ginned. In the ginning operation, raw cotton, as picked by the farmer, is processed to separate the fibers from the seed, stems, leaves, and other included trash. The cleaned fibers pass through a lint flue to a condenser where they accumulate and are eventually packed into bales of approximately 500 lb. With present mechanical samplers, a valve in the flue diverts a portion of the lint to a small condenser where the sample is collected. The valve is opened 7 to 10 times during the ginning of each bale to produce a composite sample generally about 2 by 5 in. in cross-section and 18 in. long. This sample is then usually cut into two 9-in. samples and tagged for identification.

By contrast, the traditional method has been to cut the sample from the ginned bale. Openings about 6 in. wide and 1 or 2 ft long are cut in two sides of the jute-wrapped bale and a portion of cotton is removed from each incision. The mechanical method gives a more representative sample and eliminates cutting the cover of the bale–which causes loss of cotton and gives an unsightly appearance.

Cost of machine sampling is competitive with hand sampling only for gins that produce many bales (over, say, 6000 bales annually). In these instances, either method may cost between 30 and 40 cents per bale. This does not include initial cost and installation of the sampling machinery, averaging about $5500.

In the survey of cotton growers and gin operators, USDA found the biggest difficulty with the mechanical sampler is that it occasionally fails to get an acceptable sample from the bale as it is being ginned. Even when the sampler is operated by experienced personnel, about 5% of the bales are missed. A more reliable, durable, less complicated machine is needed.

Also needed is a mechanized method for classifying different grades of ginned cotton. Grading by inspecting the sample remains largely a hand operation. Some mechanical devices have been made but are not in general commercial use. Automatic grading requires that a machine judge the length, uniformity, fineness, strength and maturity of fibers and measure the amount of included foreign matter and other properties that indicate amount of ginning preparation.

Another place where modern methods and machinery are needed: Bailing methods have changed little from those used before the Civil War. The jute bagging, which resembles a coarse fishnet, is held in place by metal bands. These bales are ragged and poorly protected, and have difficulty competing with neater packages in world markets. There have been some experiments with polyethylene bagging for special-purpose bales, but it is not entirely satisfactory for all applications.

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

working with

Du Pont Delrin®

one of Du Pont's versatile engineering materials

Air-brake couplings of Du Pont DELRIN® cost less...weigh less

By designing in a new material, Midland-Ross, Owosso, Michigan, produced a better coupling, costing less. To make these rugged couplings, which are used on the air-brake systems of truck trailers, it took a material as durable as new Du Pont DELRIN acetal resin. For example, Midland-Ross's tests require no leakage at 150 psi internal pressure, no creep in the locking ramps under 500-lb. load for 24 hours at 200°F, and operability after 5,000 breakaways. DELRIN easily passed these and other tough tests.

DELRIN is lightweight and corrosion-resistant, its non-sparking qualities offer greater safety. The resilience and stiffness of DELRIN give strength, which allows the couplings to separate under excessive load before air hoses break. Because DELRIN can be readily molded with a ramp-type lock construction, troublesome lock ball jamming and spring breakage are eliminated.

Versatile Du Pont DELRIN has already been put to good use in hundreds of applications, including household items, telephone components, gear housings, plumbing fixtures, valve parts and clothing fitments. On the next page you will find some of the product improvements made possible by the use of Du Pont DELRIN.

DU PONT

REG U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING ... THROUGH CHEMISTRY

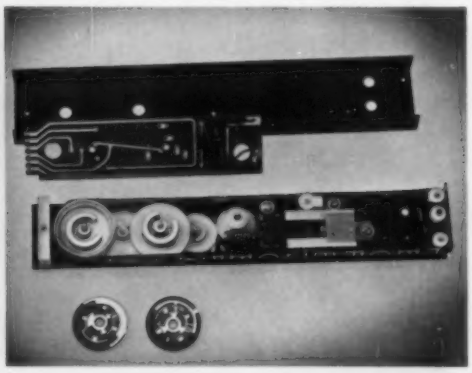
working with

Du Pont Delrin®

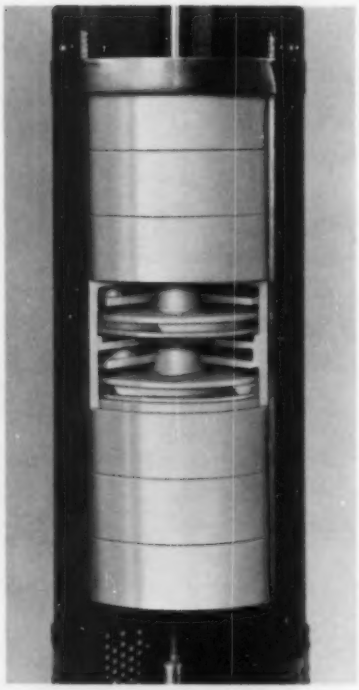
one of Du Pont's versatile engineering materials

Typical end-uses show how Delrin® is doing so many jobs once reserved for metals

Long-wearing parking-brake cable pulleys of DELRIN are being used by a leading car manufacturer. The full radius groove in DELRIN provides natural mating, maximum contact area with the cable . . . eliminates the cable pinching caused by split-type steel pulleys. Pulleys have been tested under severe long-term conditions of high load and temperatures.



In their Post-Rite® data indicator, the General Railway Signal Co., Rochester, N.Y., uses nine parts of DELRIN, molded by Control Molding Corp. These gears, cams and rollers function as a gear train that guides a printed tape to a view port upon electrical impulse. These indicators must operate without lubrication at high temperatures with minimum maintenance. Only DELRIN could provide the dimensional stability, light weight, low-friction operation required in long-term use.



In an eight-stage submersible pump (two stages shown) precision-molded parts of DELRIN replace brass components . . . making possible improved performance, increased efficiency and a substantial cost saving. The Flint and Walling Mfg. Co., Kendallville, Ind., reports that DELRIN has given superior performance over brass in abrasion resistance and corrosion resistance and the prevention of mineral build-up . . . permits "top pump performance at bottom dollar prices."

Consider the strength, stiffness, dimensional stability, resilience and abrasion resistance of DELRIN acetal resins. These properties are retained even under exposure to wide variations in temperature, humidity, solvents and stress. Already hundreds of designs taking advantage of these properties and of the cost savings made possible by rapid injection molding have been specified or put into commercial production. We suggest that you investigate how DELRIN can be profitably used in the products you make and the products you use. Commercial processors and our own staff of technologists are ready to assist you.

POLYCHEMICALS DEPARTMENT

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.), Dept. A-1 3 4
Room 2507D Nemours Building, Wilmington 98, Delaware
I am interested in evaluating DELRIN for the following use:

_____

*Name*_____

*Company*_____ *Position*_____

*Street*_____

*City*_____ *Zone*_____ *State*_____

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

DELRIN® *acetal resins*

one of Du Pont's versatile engineering materials

Alathon® · Zytel® · Lucite®

stainless steel

No other metal has the strength, beauty and versatile qualities that serve you so well today and promise so much for tomorrow.

There is nothing like stainless steel for HOMES AND HOME PRODUCTS

McLouth Steel Corporation,
Detroit 17, Michigan

Manufacturers of high quality Stainless and Carbon Steels

Look for the **STEELMARK** on the products you buy.

McLOUTH STAINLESS STEEL

CIRCLE 35 ON READER SERVICE CARD

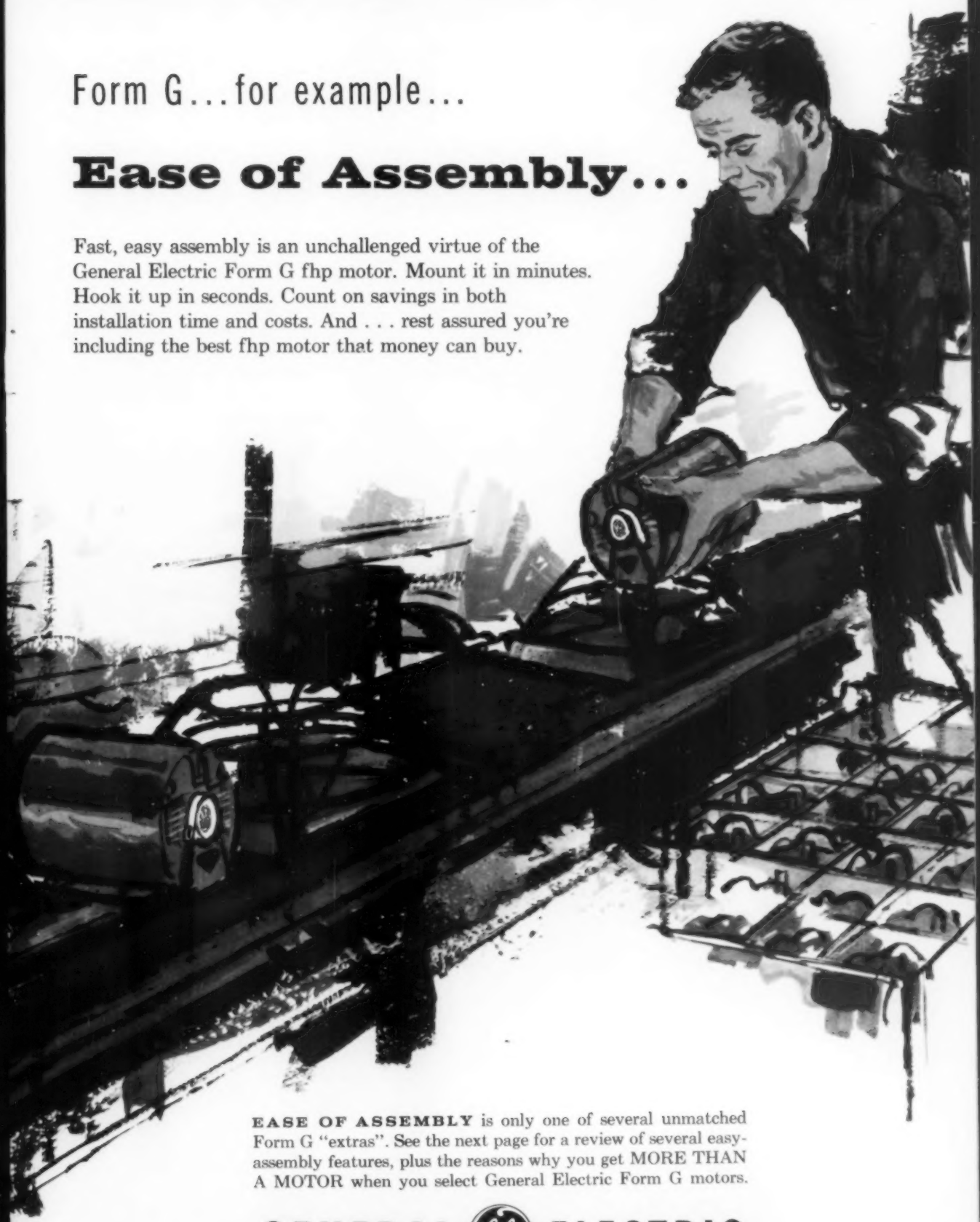
CIRCLE 36 ON READER SERVICE CARD→

You get MORE THAN A MOTOR with General Electric's

Form G...for example...

Ease of Assembly...

Fast, easy assembly is an unchallenged virtue of the General Electric Form G fhp motor. Mount it in minutes. Hook it up in seconds. Count on savings in both installation time and costs. And . . . rest assured you're including the best fhp motor that money can buy.



EASE OF ASSEMBLY is only one of several unmatched Form G "extras". See the next page for a review of several easy-assembly features, plus the reasons why you get MORE THAN A MOTOR when you select General Electric Form G motors.

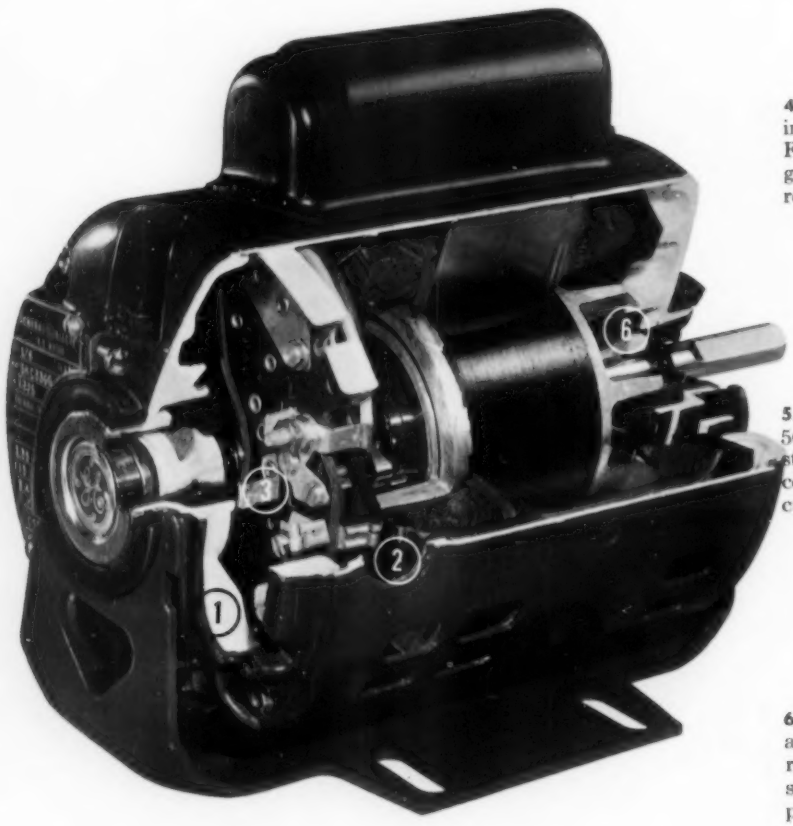
GENERAL ELECTRIC

These years-ahead Form G motor features speed assembly, cut shipping costs

1. EASY TO HOOK UP—An enlarged wiring compartment and a clean terminal board give you greater accessibility; speed connection; save you assembly-line time and money.

2. FAST CONDUIT CONNECTION—A special speed nut, welded inside the motor shell, permits conduit connection from outside; makes hook up fast, easy; simplifies motor installation.

3. FAST LEAD CONNECTION—Quick-connect wiring tabs on all external and internal terminals cut wiring time in half. Simply plug in leads for fast, easy, positive connections.



4. SAFE, SIMPLE GROUND—A built-in grounding lug on General Electric Form G motors permits fast, easy grounding of a third lead (when required) to meet UL standards.

5. COMPACT, LIGHTWEIGHT—Up to 50% lighter, 40% smaller than old-style motor designs, Form G motors cost less to handle, install and ship; cut down assembly-line fatigue.

6. ALL-ANGLE OPERATION—All-angle sleeve bearings and positive oil retention system allow you to mount standard Form G motors in any position. No need for costly specials.

Only General Electric Form Gs give you MORE THAN A MOTOR

1. EASE OF ASSEMBLY—Form G motors provide assembly-line savings in time and money.

2. EXPERT APPLICATION AID—G-E engineers are always available to help solve unusual motor applications.

3. ON-TIME DELIVERY—multi-plant facilities assure you reliable, prompt delivery of the exact motors you need.

4. YEARS-AHEAD DESIGN LEADERSHIP—consistent leadership by G.E. keeps Form G motor customers "out front".

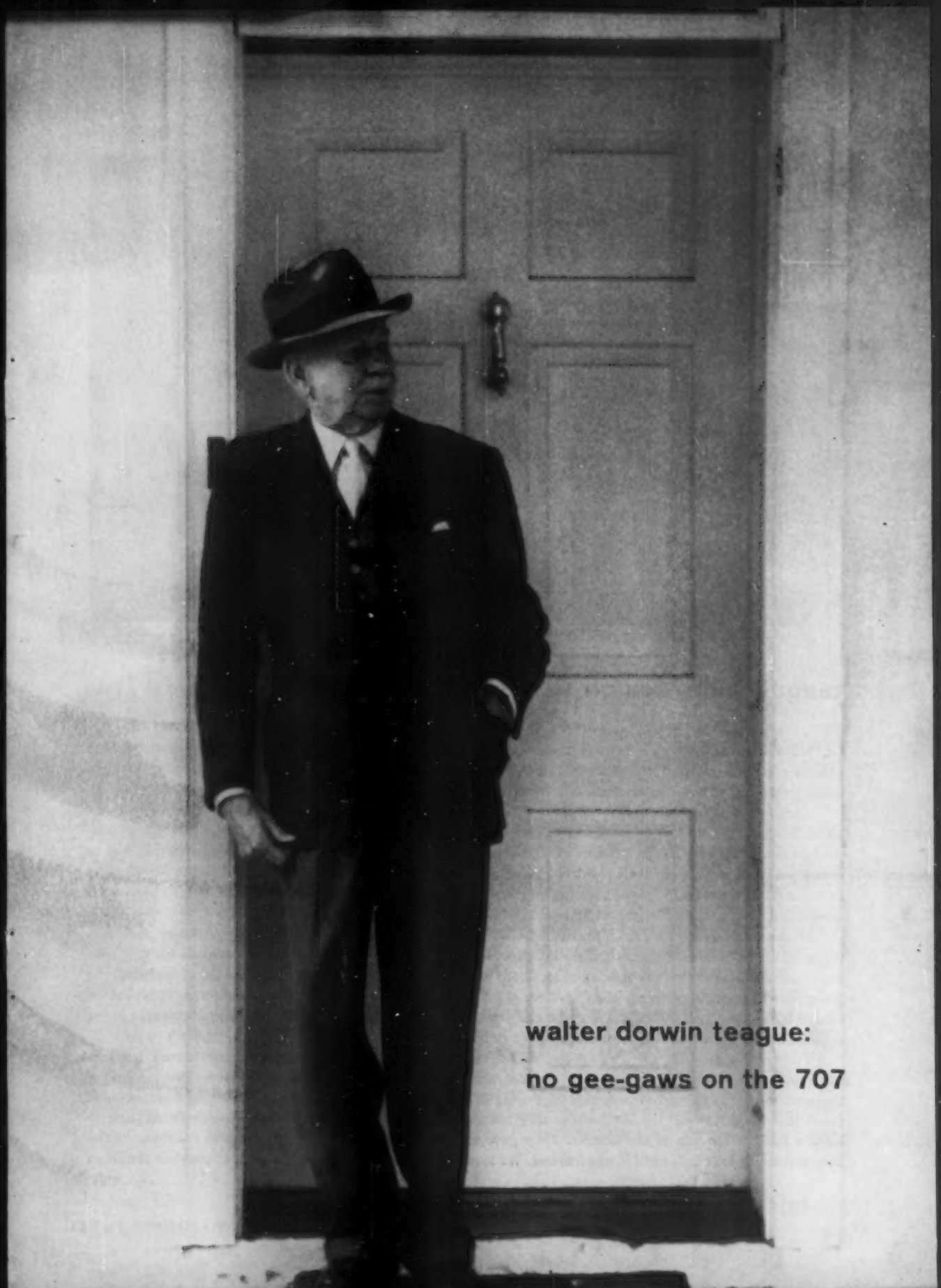
5. VERSATILITY PERSONIFIED—a Form G motor can meet almost any design requirement.

6. FAST, LOCAL SERVICE—a nationwide network of G-E Electric Motor Service Stations means service is always close at hand.

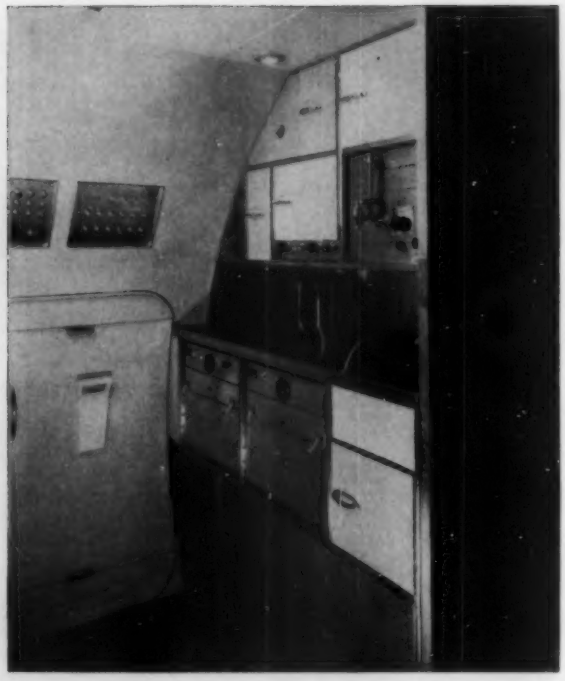
7. QUALITY CONTROL—*every* Form G motor is thoroughly tested at all stages of production to assure you long, dependable performance

Make sure you get MORE THAN A MOTOR when you select fhp drives for your product . . . choose General Electric Form G motors, available in NEMA 48 and 56 frames. For more information contact your nearby General Electric Apparatus Sales Office or write Section 702-111, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC



walter dorwin teague:
no gee-gaws on the 707



teague talks design

In 1942 a man named Walter Dorwin Teague published "You Can't Ignore Murder," a mystery novel. It is probably the only attempt at bafflement in his long history, because Walter Teague has been making products speak clearly for themselves since the Twenties.

Teague has rightly been called the dean of industrial design. He began as an artist in 1908 designing advertising, books and magazine illustrations. If you're old enough to remember Locomobile and Pierce Arrow ads, Teague designed them. In 1927, Eastman Kodak asked him to redesign their cameras. He made a proposal to spend one week a month in their plant observing production problems and techniques, and *then* redesign the cameras. That simple principle of knowing how a product is made, of understanding all the complexities of the production line, is still a Teague trademark. And Eastman Kodak is still a Teague client.

In the thirty-plus years since that camera assignment, Teague has explored just about every nook and corner of the wonderful world of three dimensions. He designed the classic Marmon 16 automobile in 1930, with his son as collaborator; he was on the Design Board of the 1939 World's Fair. When World War II exploded, the Navy asked Teague to perform design work on their 16-inch guns in order to eliminate possibilities of explosions caused by loading malfunctions. Today he still works for the Bureau of Ordnance. He has 120 people in his organization, a branch in San Juan and task forces scattered across the United States

Teague has designed service stations, railway equipment, plane interiors, heating appliances, business machines and machine tools, offices and furniture, showrooms and department stores, even periodicals. One of the most impressive things he has done is the Boeing 707 jet interiors. Mr. Teague recalls: "Boeing was concerned about their ability to sell the 707 because they hadn't made civilian planes for years. We convinced them to build a full-size mockup of the interior. They gave us *carte blanche* with body engineers to collaborate, and they refused to look at it until it was finished. We made it complete to the tiniest detail. It cost half a million

dollars and helped in selling most of the huge fleet now in the air. Our staff is responsible for the final interiors of the planes purchased by eighteen or more airlines, and for the interiors of executive planes purchased by the United States Government."

Whether mammoth jet airliners or chairs, a product is designed to five principles that are the *modus operandi* of the Teague organization. "First of all, the redesigned product has to work better for our efforts," Teague says. "It should be more convenient to use, more humanized. It must make honest use of the material it's made of, and it's got to be capable of being efficiently manufactured at the proper price. We assiduously avoid gee-gaws or extraneous ornamentation that adds nothing but price to the product. Finally, the design must give the user an emotional pleasure or gratification each time it is used." Selection of the right material for the job is important to each of Teague's requirements. "We endorse no material over another," Teague says. "We first look for the material that is best in keeping with the product's desired personality. Strength and durability are highly important in material selection. Then we make sure our client's tooling can handle the material we have in mind. Above all, it takes the right material to sell the product to the consumer."

Teague has used practically all materials known to man and it is no accident that a great many of his designs use steel in one way or another. "The wonderful thing about steel is its versatility," says Teague. "Its many alloys, old and new, give it adaptability that other materials don't have. Its strength, both in tension and compression, qualifies it for literally thousands of uses. And stainless steel is another reason why steel is a modern metal because it gives so many designs their contemporary look."

The moral is this: steel is an ageless metal, as much at home in the Boeing 707 and today's elegant tableware as it was in medieval days. Its enduring modernity will always be recognized and used by designers like Walter Dorwin Teague.

USS TRADEMARK United States Steel

designing with stainless steel

The ideal design has been described as one in which the properties of the material are fully utilized in the finished product. This ideal is difficult to achieve, and no group of materials comes as close to permitting this ideal as stainless steel.

To put it differently, no other material combines so many outstanding properties as the stainless steels. Stainless steels have high tensile strength. All are hardened and made even stronger by cold working. As a family they offer superb resistance to the corrosive effects of an enormous variety of reagents. They have unusual resistance to high temperature oxidation, and are distinguished by relatively low heat conductivity. And on top of their remarkable physical properties, stainless steel's lustrous appearance and sales appeal scarely need mention.

There are over 30 types of stainless steel today.

The history of stainless steel's use is marked by designers who turned a healthy profit with a quality material but mainly with sound ideas. They're the men who used stainless for its strength and sales appeal in toaster covers, its appearance and machinability in wrist watches, its structural properties and cleanability for truck trailer parts. Stainless steel cuts weight and adds years to the life of architectural panels; its corrosion resistance and smooth, pocket-free surface have made it the standard of the dairy industry. There are literally thousands of applications of stainless steel in which designers have utilized one, two or more of the remarkable properties of stainless steel.

By reflecting the color of its surroundings, stainless steel contributes to harmonious design.

Types 302, 410 and 430 make up 75% of stainless steel's uses.

Good design is honest design, whether it uses stainless steel or other materials. Yet the fact remains that there is no other commercial material quite as versatile as stainless steel. The applications shown on these pages are just a few of the hundreds of uses to which stainless is put every day. To learn more about stainless steel and its design properties, call our nearest sales office or write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

Successful designers don't substitute stainless steel sections for sections of other materials. They design to stainless' unique properties.

Good design doesn't stop with function and sales appeal. It must also be capable of economical manufacture. As a comprehensive guide, send for the free book described at the right.

Stainless steels represent but a few of the thousands of grades of steel in existence today. United States Steel makes a complete line of stainless steels as well as alloy, high strength and carbon steels. Bring your design problems to us.

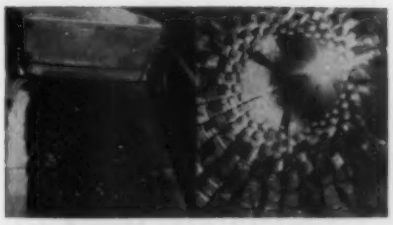
USS is a registered trademark

USS United States Steel

No Material comes close to stainless steel's versatility. By way of illustration, here are a few "opposites" that prove our point.

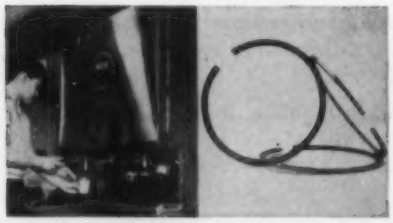
HOT. Temperatures in a jet afterburner reach 1400°F.

COLD. Stainless heat exchanger operates at temperatures as low as —443°F.



WET. Combination of moisture and coal would corrode nearly anything but stainless.

DRY. Rotary dryer is used to dry pharmaceutical ingredients.



CLEAN. Milk dispensers of stainless steel prevent contamination.

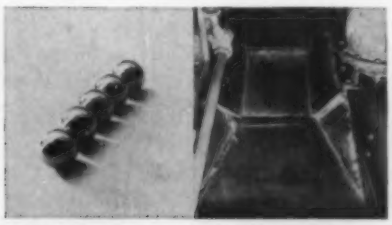
DIRTY. Stainless piston rings resist high temperature corrosion.

INSIDE. Chemical tanker needs simple wash-out for cleaning.

OUTSIDE. Stainless automobile trim stays bright and good-looking.

LIGHT. Stainless steel jewelry has a light, graceful appearance.

HEAVY. Strength and hardness of stainless combine to make safe doors safe.

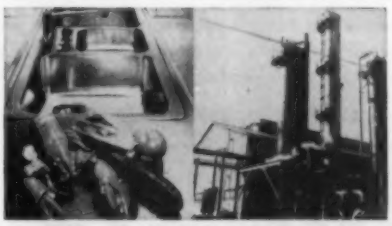


ROLL. Stainless ball bearings take a lot of punishment.

SLIDE. Abrasion resistance of stainless steel makes chutes last longer.

FORM. Stainless steel wrist watch keeps time and beauty.

FUNCTION. Stainless steel muffler defies heat with silence.



WATER. Stainless sinks stay bright and beautiful.

FIRE. Stainless steel shingles inside cat crackers are red hot.

This mark tells you a product is made of modern, dependable Steel.

Stainless steel's properties require close control over processing and in some cases, special fabricating techniques. Its cold working and joining characteristics are of special interest to the designer and will often influence final design. For complete coverage of the subject, send for your free copy of our newly revised manual:

FABRICATION OF USS STAINLESS STEEL

Welding Austenitic Stainless Steels
Welding Ferritic Stainless Steels
Welding Martensitic Stainless Steel
Brazing
Joint Preparation
Jigs and Fixtures
Removal of Scale from Stainless Steels
Soldering
Joint Design
Lining of Vessels
Riveting
Machining
Cold Cutting
Flame Cutting
Cold Forming
Hot Forming
Annealing
Scale Removal
Passivation
Standard Mill Finishes
Surface Finishing
Grinding, Polishing and Buffing
Etching
Protection of Stainless Surfaces
Cleaning of Stainless Steels

United States Steel
Room 6144
525 William Penn Place
Pittsburgh 30, Pa.

Send me your new, just-off-the-press "Fabrication of USS Stainless Steel."

Name_____

Title_____

Company_____

Address_____

City_____

Zone____ State_____

NEW! DUAL TORQUE-LOCKING AND POSITIONING DEVICE

REV-LOK eliminates feedback torque, provides two-directional positioning, drive, over-running and backstopping

NOW! You can have positive and instantaneous stopping of feedback (reverse) torque—it will never reach the driving equipment. For, the complement of sprags in this new Formsprag device is divided into two opposing sets that: instantly stops feedback from either direction, assures equalized radial loading, evenly distributes wear for longer life, and provides multi-contact surfaces for greater holding strength when high feedback torque occurs.

When the device is mounted with the outer race in a fixed position, feedback is stopped by wedging of sprags between output member and I.D. of fixed outer race —feedback never reaches the input shaft. Yet, this new design permits free rotation and transmission of high driving torque in either direction from input to output shaft. Current catalog models are available in ratings up to 30,000 lbs/in. and with bore diameters to 2½".

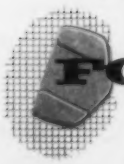
When used as a two-directional over-running clutch, output shaft member is mechanically secured against rotation and outer race then becomes the output member. A slight right or left rotation of input shaft disengages either set of sprags and determines direction of drive, over-running and backstopping.

This versatile device can also be used for two-speed drive and reversing applications. By connecting a low-speed reversible motor to outer race and a high-speed motor to input shaft member, driving torque can be transmitted at two speeds or reversed.

Smallest standard Rev-Lok sizes (⅜" and ¼" shaft diameters, 96 lbs/in. output and holding capacity) have the following additional features: mounting flange on outer race, end-to-end or coaxial drive, completely enclosed and permanently lubricated, economical sleeve bearings and roller type contacts.

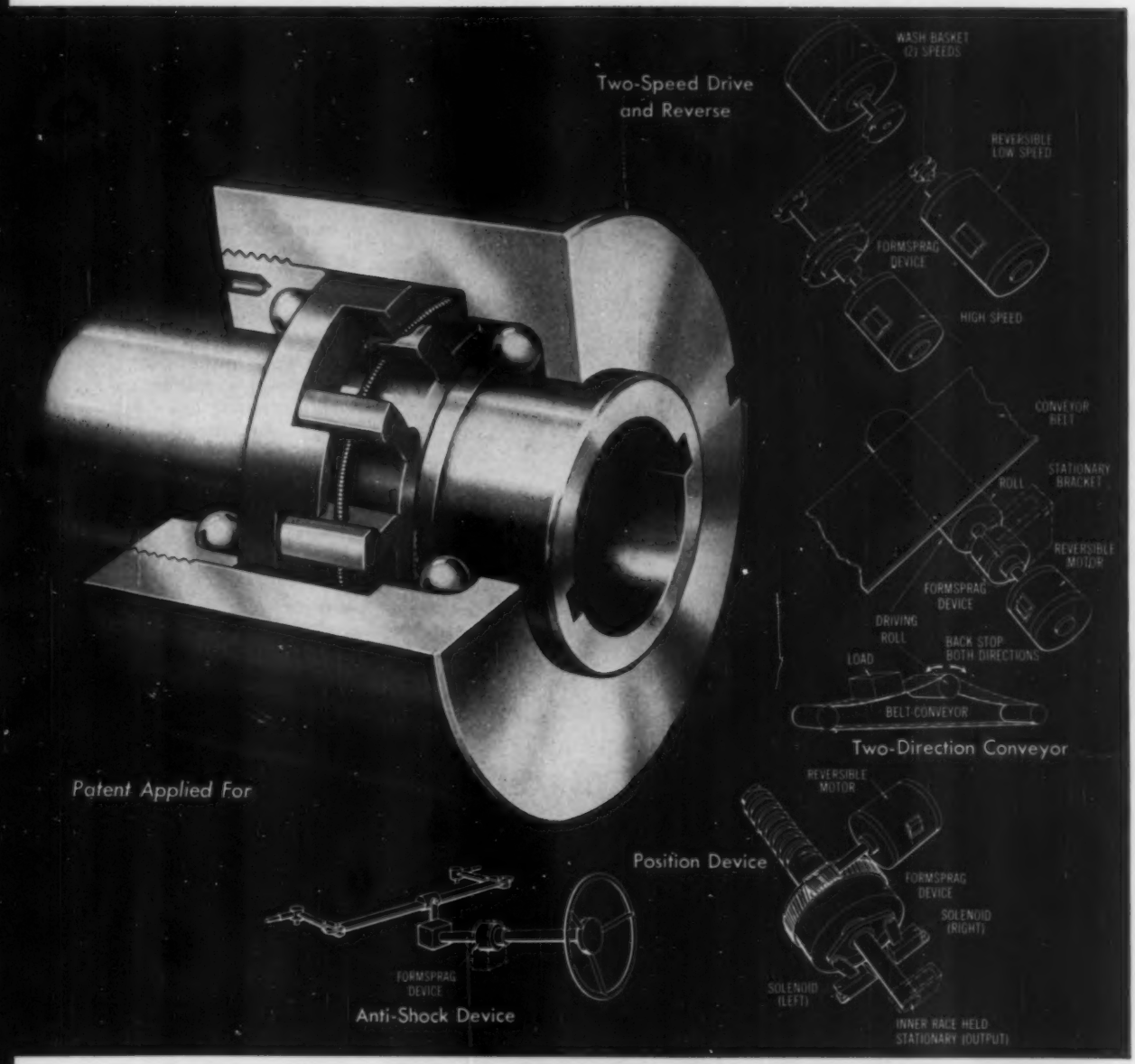
Rev-Lok devices not only drive, position, over-run and backstop in two directions, but they also provide automatic, instantaneous and positive prevention of feedback from driven equipment to power source. They are compact, have greater torque capacity for their size and weight and permit higher over-running speeds than any similar device. Formsprag technical paper provides further details on operation and features, send for your free copy.

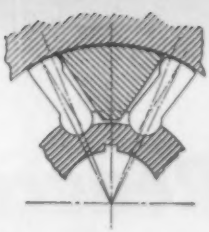
FORMSPRAG COMPANY, 23607 Hoover Road, Dept. 105R, Warren (Detroit), Michigan
Distributors in Principal Cities.



FORMSPRAG COMPANY

Precision Power Transmission Products





BECAUSE there is a complement of sprags arranged in opposing pairs, there is always a multiple number of contact surfaces engaging the outer race when feedback or backstopping conditions are present. This provides equalized radial loading and strong holding torque against even unusually heavy feedback.

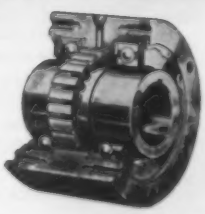
The entire complement of sprags, which is a part of the output member assembly, rotates at driving speed while outer race remains stationary. Thus, sprags are in light contact with the outer race and are always in position to pick up the feedback load at constantly changing points on the outer race. This design feature assures longer life through even distribution of wear over entire surface of outer race. With sprags in constant contact with outer race, any independent movement of output shaft causes instantaneous locking of sprags—there is no backlash on output shaft.

RAWSON Centrifugal Clutches

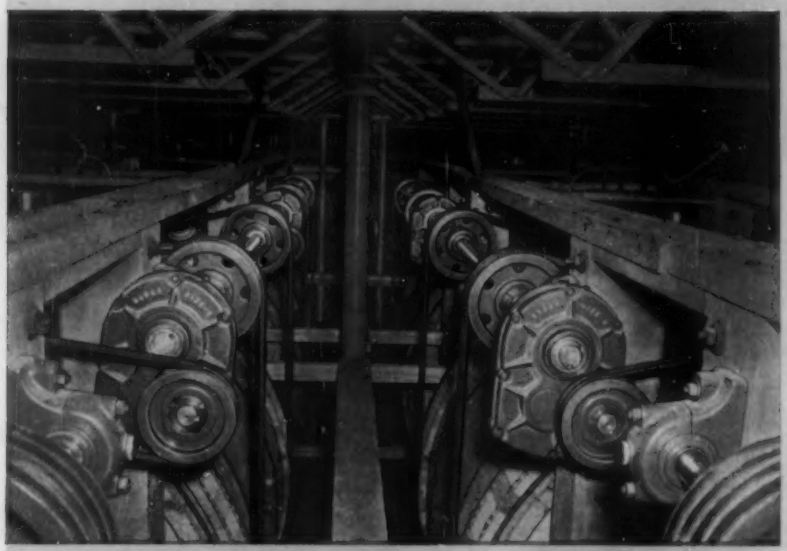
No-Load Motor Starts, Cushioned Starting of High-Inertia Loads, Overload Protection.

OTHER FORMSPRAG PRODUCTS

FORMSPRAG Over-Running Clutches

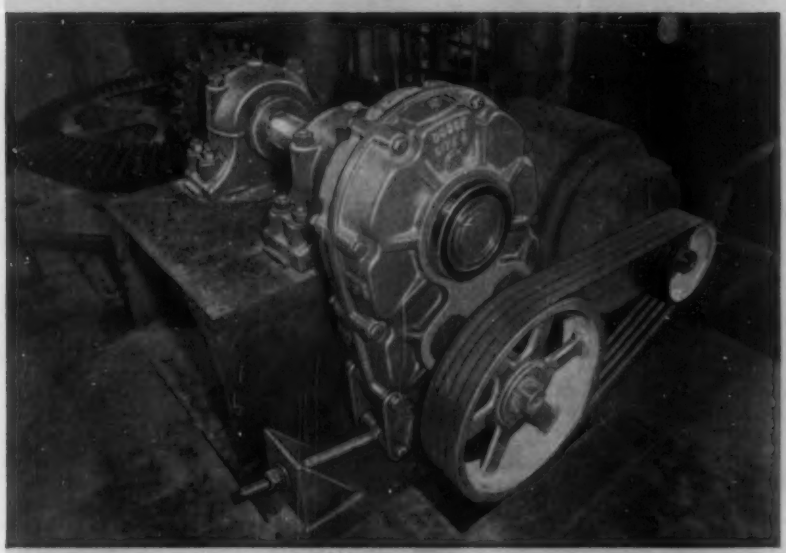


For Every Over-Running, Indexing & Backstopping Application



DODGE TORQUE-ARM SHAFT MOUNTED SPEED REDUCER

Install it anywhere—with minimum time and effort. Here is an overhead installation on tanning drums. Torque-Arm reducers are resistant to acid fumes, salt water environment, moisture.



DODGE TORQUE-ARM SHAFT MOUNTED SPEED REDUCER

Can be positioned any place on the entire length of the shaft. It locks into place on *both* sides of the housing. Note modified torque arm on this installation on a mixer in a beverage plant.

The Speed Reducer Idea that

Two things account for the record popularity of Dodge Torque-Arm Speed Reducers. First, they cost less to install since they require no foundations, sliding motor rails or flexible couplings. Second—and most important—these modern reducers as developed by Dodge perform *brilliantly*. Tens of thousands of installations underscore Torque-Arm dependability. Torque-Arm is America's *quality* shaft mounted speed reducer!

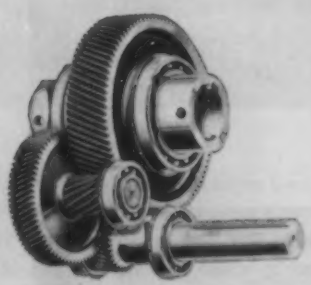
Torque-Arm has been so extensively adopted by industry that today models are available for a vast range of applications. The Torque-Arm line offers you capacities up to 170 hp—output speeds from 10 to 400 rpm—in single and double reduction series—with 5 to 1, 15 to 1 and 25 to 1 ratios. Models for vertical or inclined shaft operation are available—as well as special-application versions such as flange mounted, right

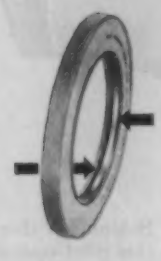
Rugged semisteel housing— a solid backbone for solid service

Here is a tough, corrosion-resistant housing with the strength to hold bearing seats in line for the life of the unit. Perfect shaft and gear alignment are assured by doweling the matched halves together and boring in line. No gear is overhung. Loads are carried easily, contributing to Torque-Arm's long life and high efficiency—97% in double reduction models, almost 99% in single!

AGMA rated gears— quality-guarded by continual tests

These helical gears have soft cores to withstand shock—and hardened surfaces to resist wear. Their quality is guarded in manufacture and assembly by the most modern methods of quality control, including inspection for runout, tooth spacing, helical lead and involute profile. They run quietly, mesh precisely. Teeth are crown shaved for maximum contact area. Gears are shrunk on their shafts to prevent shifting.





Modern double-lip seals keep oil in and dirt out

Modern synthetic, double-lip seals of the highest quality keep oil in and dirt out of the reducer case. These seals offer protection for the unit from dust and dirt and just as effectively insure cleanliness when operating in laundries, textile mills, food processing plants.

Re-ally Clicked!

angle and extended input shaft styles. Optional equipment includes a positive, sealed-in backstop and a positive overload release.

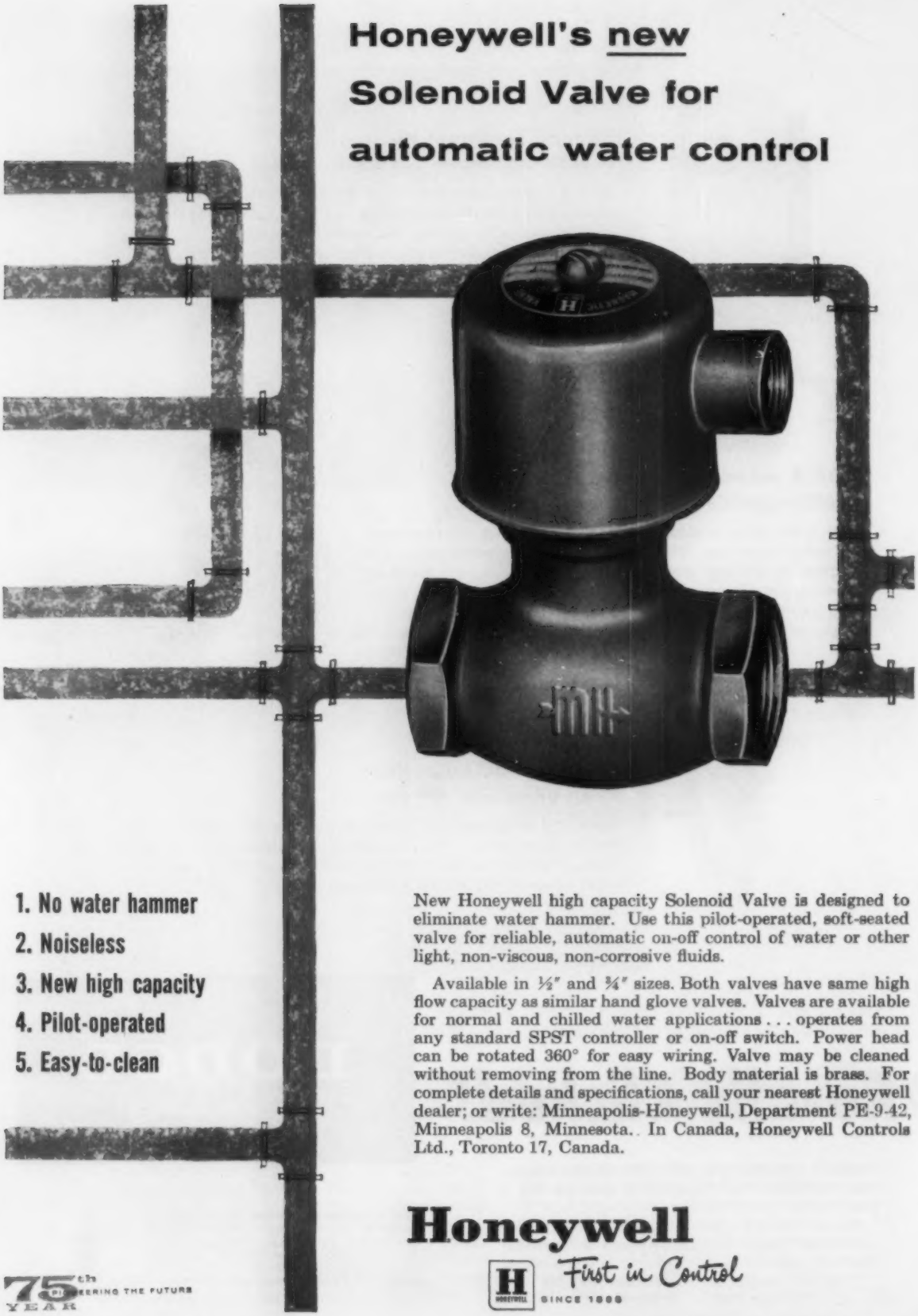
Ask your local Dodge Distributor. Or write us for our 64-page Torque-Arm Speed Reducer Bulletin, complete with engineering data and easy selection tables.

DODGE MANUFACTURING CORPORATION
1200 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

Honeywell's new Solenoid Valve for automatic water control



1. No water hammer
2. Noiseless
3. New high capacity
4. Pilot-operated
5. Easy-to-clean

New Honeywell high capacity Solenoid Valve is designed to eliminate water hammer. Use this pilot-operated, soft-seated valve for reliable, automatic on-off control of water or other light, non-viscous, non-corrosive fluids.

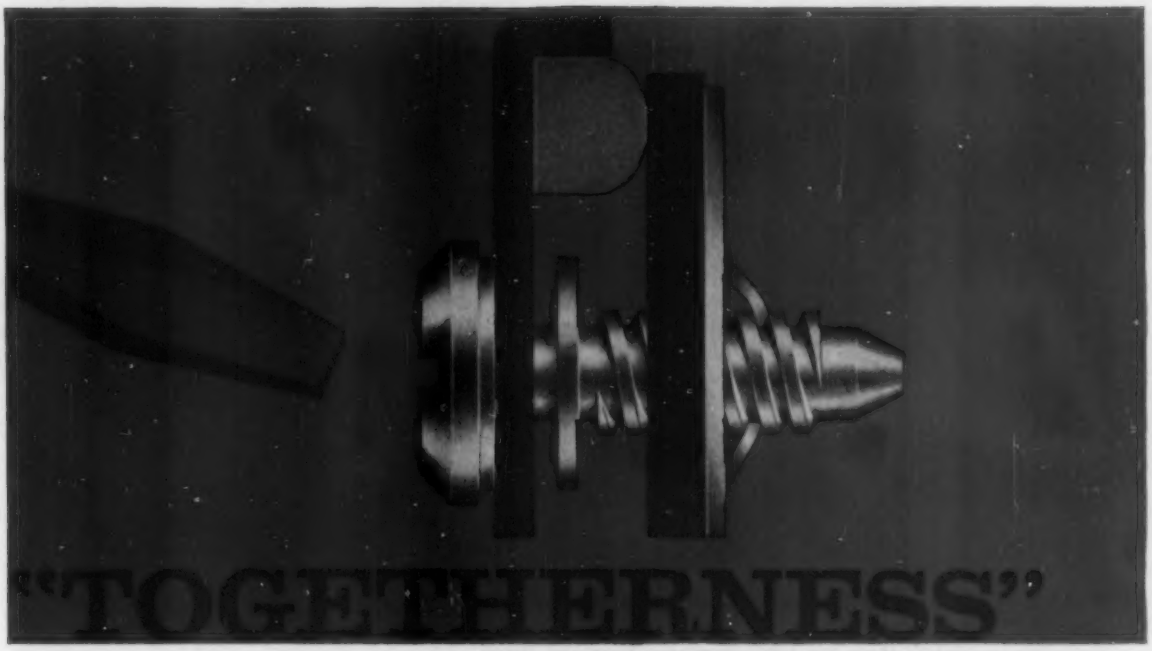
Available in ½" and ¾" sizes. Both valves have same high flow capacity as similar hand glove valves. Valves are available for normal and chilled water applications . . . operates from any standard SPST controller or on-off switch. Power head can be rotated 360° for easy wiring. Valve may be cleaned without removing from the line. Body material is brass. For complete details and specifications, call your nearest Honeywell dealer; or write: Minneapolis-Honeywell, Department PE-9-42, Minneapolis 8, Minnesota. In Canada, Honeywell Controls Ltd., Toronto 17, Canada.

Honeywell

First in Control

SINCE 1885

75th YEAR — PIONEERING THE FUTURE



is a lasting benefit when you fasten with aluminum

You can expect two big advantages when you switch to aluminum fasteners: a fastening that stays strong . . . improved product quality and appearance.

Unlike many fasteners made of other metals, aluminum fasteners resist corrosion and do not form the destructive oxide called rust. The colorless oxide formed on aluminum is a *protective* shield which resists further oxidization and corrosion. *The life of the fastening is actually prolonged when you use aluminum fasteners.*

Some metallic fasteners must be coated to prevent corrosion, and these coatings can be damaged in production, opening the way for product deterioration. Aluminum fasteners stay strong and clean; they need no protective coatings. However, aluminum can take a wide range of finishes to meet virtually any product design requirement.

Unlike other metals, aluminum won't stain or weaken because of rust. Parts and products are not only fastened firmly, they stay good looking longer.

Be sure all aluminum parts are fastened with aluminum fasteners. Dissimilar metals sometimes set up damaging corrosion, rust, deterioration, and weakened fastenings.

The next time you specify fasteners for any metallic, wood, or plastic part, consider aluminum and aluminum quality. If you would like further information on aluminum fasteners, write to *Reynolds Metals Company, Box 2346-NB, Richmond 18, Va.*

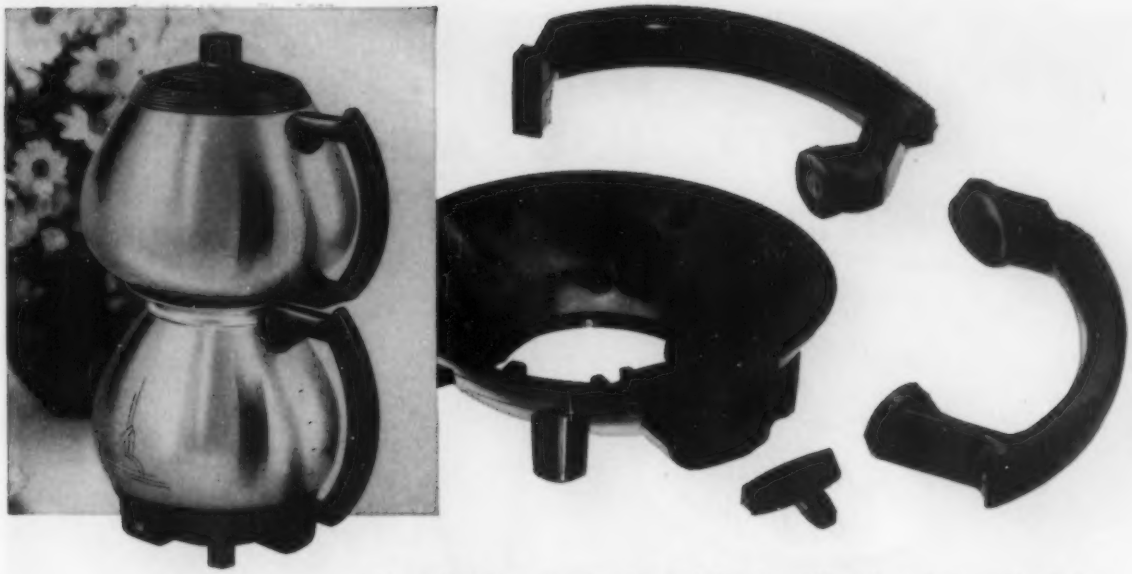
Reynolds does not make aluminum fasteners, but does supply the finest quality aluminum to the fastener industry...write today for the names of leading manufacturers.

REYNOLDS ALUMINUM

Molded Vinyl Provides Flexibility and Color Harmony in Steering Wheel Grommet. Color matching without painting, flexibility as needed—these are two advantages BAKELITE Brand vinyl offers in these grommets for Mercury cars. Used to enclose the steering column at the instrument panel, the grommets are molded in colors to harmonize with car interiors. Flexibility of the vinyl permits the grommet to fit snugly and eliminate road vibration. A cost saving over the rubber used previously was another important advantage.

FOR A FRESH NEW LOOK,

Colorful High-Impact Styrene's Light Weight Makes This Portable Sewing Machine Easier to carry. Durability and a pleasing appearance enhance the sales appeal and service life of the carrying case for Singer's new portable sewing machine. The BAKELITE Brand high-impact styrene plastic cut four pounds from the weight of the old-type case, and gives a high-gloss finish in lasting color. Moldability of the BAKELITE high-impact styrene proved best of several plastics tested before production began. Matching base and accessory box are molded from the same material.



Phenolics Improve Looks and Service Life of an Automatic Coffee Maker. Main considerations in the design of this utensil were attractive appearance and heat resistance. BAKELITE Brand phenolics met both requirements at low cost. Base, handles, and upper rim were molded from phenolic resins developed by Union Carbide Plastics Company. They don't warp or blister and keep their lustrous finish even though frequently exposed to hot fumes and coffee grounds.

REDESIGN IT IN PLASTIC

When your product must be handsome as well as efficient, molded plastic components can give it fresh eye-appeal and durability that influence buyers

Is the sale of your product hampered by an unattractive or outmoded appearance? Then start anew, and design it freely, according to your ideas of what it could look like.
You have more freedom when your design calls for fabrication with BAKELITE Brand plastics. Choose from numerous BAKELITE Brand plastics—polyethylenes, epoxies, phenolics, styrenes, and vinyls—all are high quality, and offer you a wide range of properties. You can get colors, impact strength, heat and ultraviolet resistance, light weight; plus the fabricating characteristics you need. And more than likely you'll realize a cost saving besides.

See your Sweet's Product Design File, Sec. 2a/ui for properties of BAKELITE Brand plastics. For specific information, just mail the coupon.

BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

UNION CARBIDE

Dept. DG-113,
Union Carbide Plastics Company
Division of Union Carbide Corporation
270 Park Avenue, New York 17, New York

Please send me details about BAKELITE Brand plastics for molding applications. Application being considered is

_____

NAME _____

FIRM NAME _____

STREET _____

CITY _____ ZONE ____ STATE ____

CIRCLE 51 ON READER SERVICE CARD 51

WRITE YOUR OWN RELIABILITY INSURANCE HERE...

Wherever metals are being cast, forged, or fabricated, the important factor of reliability can be assured by specifying R_xMet brand alloys. Whether we ship shot for making castings, billets for forging, or special welding rod, the R_xMet label on the alloy means more consistent performance in the finished product.

At WaiMet, metallurgical reliability and quality control are more than words—they are integral parts of a dedicated approach to making better alloys. We dig a little deeper than most to find out why an alloy behaves as it does, then define new limits of chemistry to guide the production of every heat. Result: alloys with reproducible, consistently better mechanical properties.

In almost every alloy we make there is some WaiMet improvement in processing or heat treatment technology that will mean better reliability insurance for the user.

HERE ARE TYPICAL REASONS WHY ALLOY USERS SPECIFY R_x MET®

USER OF:	SPECIFIES IT FOR:	USES R_xMET BECAUSE:
410	Aircraft wing hinge	Cleaner melting and tailored chemical composition.
WI - 52	Gas turbine blades and vanes	Greatly improved high temperature strength
17-4PH	Gas turbine compressor blades	Uniformly high level mechanical properties
SUPER 3	Agricultural equipment twine guide	Superior wear resistance at low metal cost.

WAI MET ALLOYS CO.
5320 OAKMAN BLVD.
DEARBORN 2, MICH.
LUzon 1-7200

Put WaiMet's technical team to work for you at the design stage. Specify R_xMet whenever reliability is important in stainless, heat resistant alloys, or superalloys. For information on the R_xMet alloy line, just drop us a line, or call.

QUALITY TEFLON* FROM PARCO...

temperature and dust controlled environment insures uniform accuracy for parts from
TEFLON* · KEL-F† · NYLON · POLYETHYLENE · DELRIN**

Only within environmentally controlled conditions can Teflon's unique characteristics be fully realized. Parco's new Fluorocarbon plant is equipped with rigidly accurate equipment that maintains a constant temperature of 72°... eliminating expansion and contraction problems that could result in size variance. Since the slighest speck of foreign material is enormously magnified with resulting product weakness, the entire Parco molding facility is internally pressurized to keep foreign-borne particles *out*. Extensive filtration equipment further assists in maintaining product cleanliness and quality. ■ Parco's complete inventory of AN and MS parts assures prompt delivery of these popular items: **O-RINGS • V-RING PACKINGS • TEFLON SCRAPER RINGS • GROMMETS • STATIC FACE SEALS • BACK UP AND SPIRAL BACK UP RINGS** • *Special part design and fabrication facilities* • Send for free Brochure.

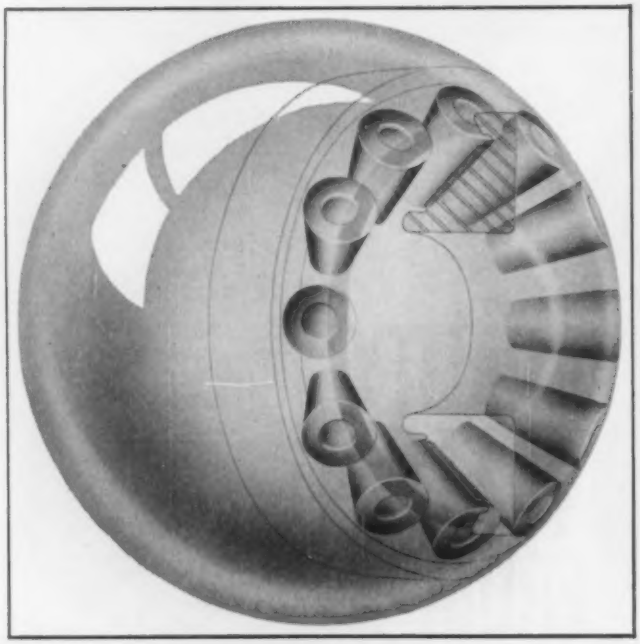
*DuPont Trademark for T.F.E.-fluorocarbon resin
**DuPont Registered Trademark for Acetal Resin
†M.M.&M. Trademark

PLASTIC AND RUBBER PRODUCTS COMPANY FUOROCARBON DIVISION
2100 Hyde Park Boulevard • Los Angeles 47, California

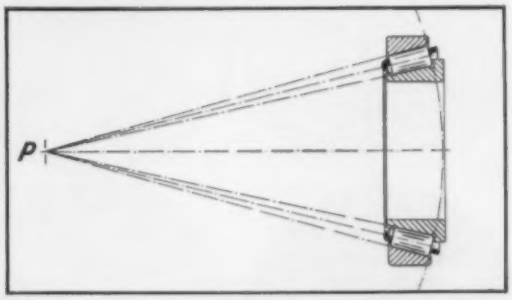
One in a series of technical reports by Bower

BEARING BRIEFINGS

SPHERICITY — ESSENTIAL TO MAXIMUM BEARING PERFORMANCE



When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.



True rolling of tapered bearing elements depends upon maintaining a true spherical radius during manufacture.

For a tapered roller bearing to achieve maximum performance, i.e., maximum life and capacity under load, it must have true sphericity — a condition of bearing geometry which permits true rolling of the tapered rollers in the raceway.

True rolling in tapered bearing elements is the result of maintaining a critical geometric relationship between the raceways and the contact surfaces of each roller. True rolling is essential to maximum performance. Without it, premature bearing failure is certain.

As engineers know, a tapered roller will describe a true circle when rolled on a plane surface. *It will always roll in this one path precisely, without sliding or skewing.* But to put true rolling to work in a bearing which can carry both heavy thrust and radial loads, it is essential that the rollers *and* the raceway have a true spherical radius, or sphericity. The drawing illustrates this condition.

If each roller in the bearing were to be extended in length, while retaining its taper, it would form a cone, terminating at point "P". All cones generated from all rollers would meet at point "P", which is also the center of the hypothetical sphere shown. The surface of the sphere would *touch all points on each roller's head!*

In effect, then, each roller's taper determines the radius of a hypothetical sphere whose surface, in turn, determines the correct contour for each roller head. Only when these conditions are satisfied in design, and when they are rigidly held during manufacture, will true rolling take place. In the manufacture of each Bower tapered roller bearing, sphericity is held within extremely narrow limits by means of special Bower-designed precision grinders. The consistent accuracy possible with these machines is one major reason why Bower roller bearings provide maximum performance under all speeds and loads up to the bearing's maximum rating.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

CIRCLE 54 ON READER SERVICE CARD

CIRCLE 55 ON READER SERVICE CARD→

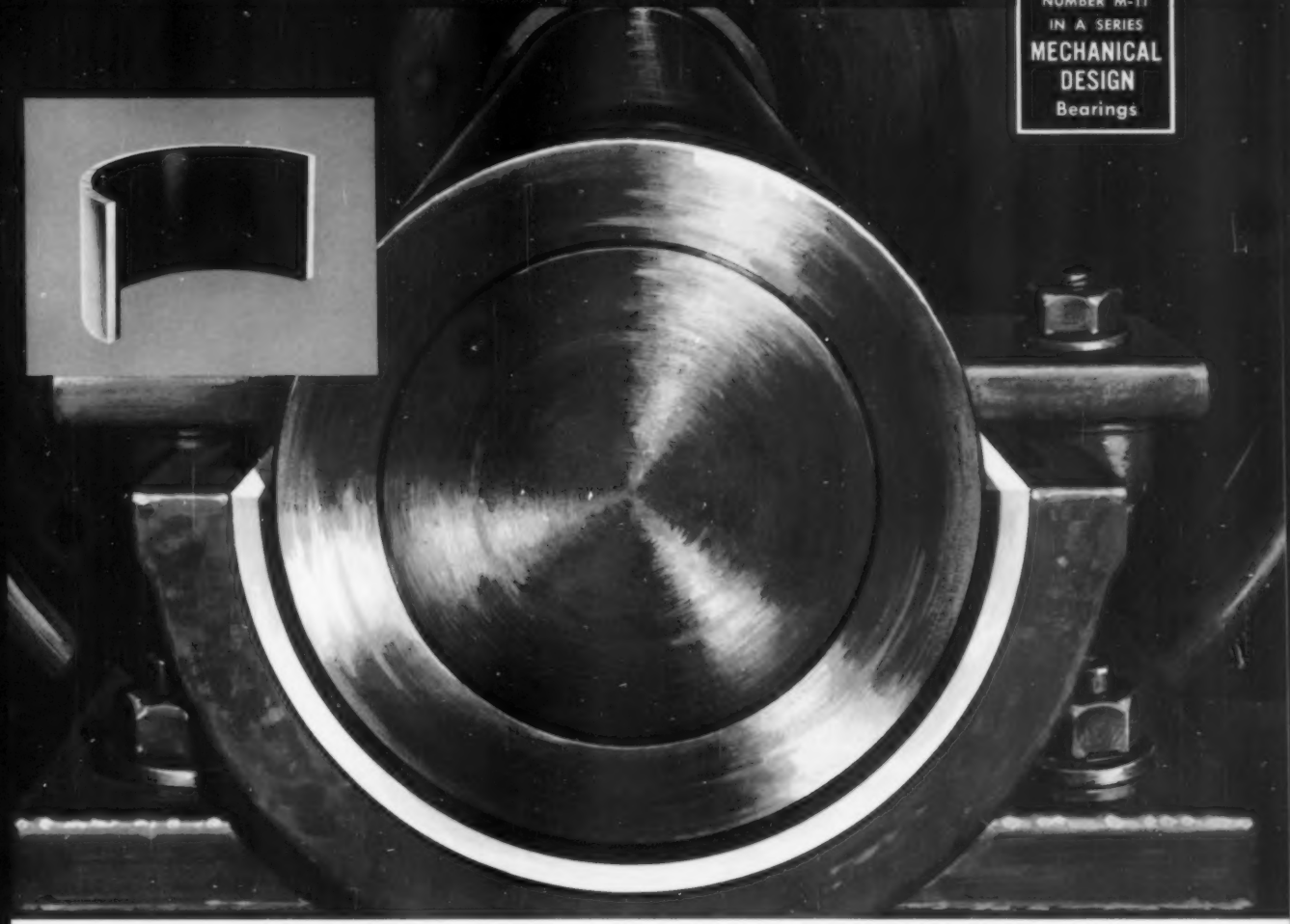
DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER M-11
IN A SERIES
MECHANICAL
DESIGN
Bearings



Downtime problems solved by non-lubricated bearings of TEFLON®

Costly shutdowns for lubrication were required in the dryer section of a papermaking machine . . . until the journal bearings were replaced by bearings using a filled composition of a Du Pont TEFLON TFE-fluorocarbon resin. The exceptionally low coefficient of friction offered by TEFLON resins now makes lubrication unnecessary. In addition, the new bearings eliminate problems of oil leakage, splatter and contamination of paper which had previously occurred.

These bearings of a filled TEFLON resin, reinforced by a rigid backing material, operate smoothly up to 1,000 psi and 150 surface feet per minute.

If your equipment involves problems of bearing life, performance or lubrication, consider the time and money saving advantages offered by bearings of TEFLON. Filled compositions and reinforced constructions of TEFLON are available to meet the requirements of increased load and speed or high wear resistance—and TEFLON fluorocarbon resins provide dry lubrication.

On the following page you will find basic data on the properties and performance of bearings of TEFLON and the ways they make possible cost-saving design improvements.

OVER

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.

Bearings of TEFLON®: major design considerations

FIGURE 1

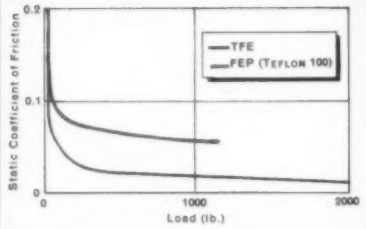


FIGURE 2

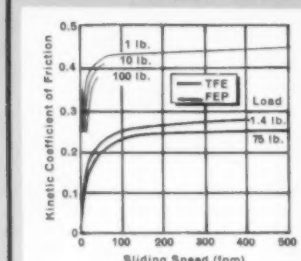


TABLE 1

UPPER SERVICE LIMITS OF VARIOUS CONSTRUCTIONS

Material	Load (psi) < 2 ft. per minute velocity	Velocity (ft./min.) 100 psi load
Unmodified TFE resins	500	25
Compounded TFE resins	2,500	200
Reinforced TFE resins	40,000	1,000
Fabric of oriented fibers of a TFE resin	60,000	60

TABLE 2

Construction	Wear	Conditions
Molded TFE resins		
unfilled	200 mg./hr.	410 stainless steel shaft
25% graphite	0.7 mg./hr.	1" long x ¾" I.D.
22% glass	0.2 mg./hr.	60 ft./min. 42 lbs.
25% copper	1.2 mg./hr.	
25% graphite	0.7 mg./hr.	410 stainless steel shaft
22% glass	0.4 mg./hr.	1" long x ¾" I.D. 215 ft./min. 21 lbs.
unfilled	0.74 mg./hr.	303 stainless steel shaft
15-25 graphite	0.0015 mg./hr.	½" long x ¼" I.D.
15-25 glass	0.0015 mg./hr.	9.8 ft./min. 35 psi
4-8 copper	0.032 mg./hr.	White, H.S. National Bureau of Standards
Fabrics of oriented fibers of TFE resins	6×10^{-4} in./hr.	1" shaft 25 ft./min. 1150 psi
Reinforced TFE resins	4×10^{-7} in./hr.	1" shaft 100 rpm 2000 psi

Properties of bearings of TEFLON

TEFLON fluorocarbon resins have properties which make them excellent materials for journal and plane-surface bearings. Filled compositions and reinforced constructions are usually used to tailor bearings of TEFLON for increased loads and velocities or high wear resistance. Among the major benefits that TEFLON resins offer as bearing materials are:

1. Low coefficient of friction—The static coefficient of friction of TEFLON resins is even lower than the dynamic value. At high loads and low velocities, TEFLON resins have a lower friction than any other solid material . . . significantly lower than lubricated metal bearings. (See Figure 1 for static coefficients of both TEFLON TFE resins and the new, melt-processible TEFLON FEP resin. The kinetic coefficients of friction vs. sliding speed at 73°F. are shown in Figure 2.)

2. Temperature resistance—Bearings of TEFLON TFE resins have exceptional thermal stability and are suitable for continuous service up to 500°F. At -450°F. these resins show the same friction that would be expected for similar conditions of load and velocity at room temperature.

3. Chemical resistance—Bearings of TEFLON resins are completely resistant to virtually all chemicals and solvents. They do not absorb moisture and are completely unaffected by outdoor exposure to weather.

4. Other properties — Bearings of TEFLON resins are tough, abrasion resistant, and have the ability to embed hard foreign contaminates.

WHERE TO USE

Bearings made of TEFLON resins are being used where lubricated bearings are undesirable or incapable of operation, in extreme temperatures or corrosive conditions, or where there is a possibility of lubricant failure. They are used where safety and reliability are essential. They are used near substances that must not be contaminated; with non-lubricating liquids such as gasoline; with corrosive substances; at low or high temperatures where common lubricants are useless; under extreme conditions of humidity; in areas where there is danger of fretting or galling; where stick-slip motion is undesirable; where space or weight savings are essential.

SPECIAL CONSIDERATIONS

Load and Speed

Unfilled TEFLON resins are used in light load, low PV factor bearings. For higher loads and speeds, reinforced constructions and filled compositions of TEFLON provide the increased compressive strength, thermal and dimensional stability, heat dissipation and wear resistance required. See Table 1 for indications of the capabilities of various types of bearings of TEFLON TFE resins.

Bearing Life and Wear

Bearing life is usually dependent on wear, which in turn is dependent on load, surface sliding speed, lubrication and shaft finish, as well as clearances and construction. Hence, it is not practicable to define wear rate for all conditions. Table 2, however, is indicative of the wear rates for some typical bearing applications.

FOR MORE INFORMATION about the properties and uses of bearings of TEFLON and the new fact-filled booklet "Designing with TEFLON", write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department T-36-9, Room 2526, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

DU PONT REG. U.S. PAT. OFF.

TEFLON®
FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

ACCORDION DOORS

HOME MAILBOXES

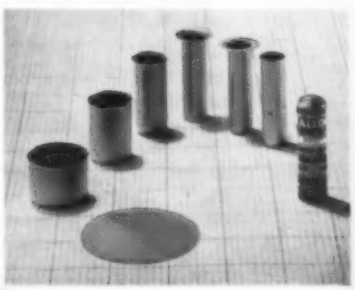
LUGGAGE LOCKS

LIPSTICK BASES

CABINET HARDWARE

HOW TO CUT COSTS, BOOST PRODUCT APPEAL WITH THOMAS STRIP PRE-COATED STEEL

please turn page



BATTERY CANS

BOILER TOPS

Pittsburgh Steel Company

Pittsburgh Steel Company

Luggage Locks—Brass Coated strip "strongly helped us compete against low-cost, brass plated imports." That's acclaim John A. Long, vice president-general manager, Long Manufacturing Co. Inc., gives Thomas Strip's brass coated steel. Long, of Petersburg, Va., is the nation's second largest luggage hardware maker. It was hard hit by foreign-made brass locks. "It was a crucial time in one of our big markets," says Sales Manager Edward C. Coleman. "We started looking for new methods and materials. Now, with new designs and using Thomas brass coated strip, we're able to fight foreign competitors." Eliminating plating and hand polishing with brass coated strip, buffed and lacquered on one side, Long trimmed 11 production steps. Result: 50% cost saving on compact-type luggage lock. Thomas Strip maintains product quality, helps Long increase die life; clear lacquer coat acts as lubricant in forming, prevents galling, and preserves product finish in inventory and in handling.

THOMAS STRIP: TRIMS METAL COSTS, SAVES PRODUCTION STEPS, UPGRADES PRODUCTS

Metal fabricators get a head start toward material and production savings with Thomas Strip's coated steel specialties.

Combining the beauty and utility of costlier metals with the strength, economy and formability of steel, Thomas Strip also offers greater product versatility, durability, buyer appeal and design potential.

Here are benefits available to you in Thomas Strip:

• **Shortens Manufacturing Cycle**—Precoated Thomas Strip is ready to fabricate when it's delivered. Initial preparation, cleaning, buffing, final finishing are already done in many cases—you're steps ahead in production.

• **Provides Economy of Steel**—By replacing more expensive metals, but retaining their finish or functional properties, precoated Thomas Strip reduces material costs.

• **Fabricates Easily**—Electrolytically applied, hot-dipped, painted or bonded, Thomas Strip coatings endure fabrication as readily as easy-to-work base steel.

• **Cuts Plating Costs**—Serving as final finish or as base for further plating or painting, Thomas Strip eliminates or at least reduces fabricators' piece-plating expense.

• **More Pieces Per Pound**—Precision rolling and plating to extremely close tolerances give maximum yield in parts per pound.

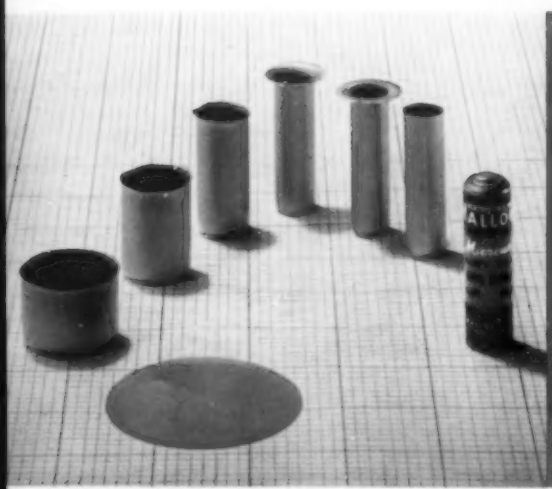
A study of the experiences of Thomas Strip users pictured on these pages should convince you of the benefits available to your product application—or to that product idea in the back of your mind. Read them.

If you need more convincing, detailed literature and samples are yours for the asking.

Better yet, contact one of the Thomas Strip District Sales Offices on the last page and ask for engineering or design help. And tell them you'd like to see our new slide film, "Bright, Modern Metals Provide Proof of the Pudding."

Accordion Doors—Plastic Coated Thomas Strip replaced hand laminating for "lead rail" of STEELITE plastic folding doors made by Clopay Corporation, Cincinnati, Ohio. Strip is roll formed with six 90° bends, ribbed and punched for rivets and door handle. Plastic endures stretching and compression. Also maintains "perfect lamination" to pass 100% inspection, says Purchasing Agent Lewis H. Washburn. Formed rails (left foreground) are assembled on rivet bench.

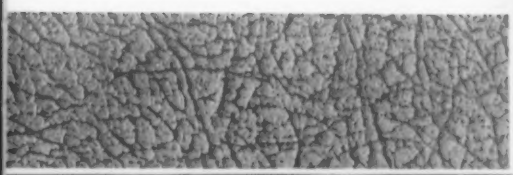
Boiler Tops—Lacquered Strip is spun formed by Edwards Engineering Corp., Pompton Plains, N. J., for boiler tops and top collars in packaged heating systems. Lacquer coat on Thomas Strip's aluminum-killed, drawing quality steel adheres without chipping or peeling. Edwards also uses lacquered strip to roll form back plates and front shields for baseboard units. Purchasing Agent John Bush says: "Thomas is more flexible and cooperative in giving us a quality product. We cut six steps, gained 1,500 sq. ft. of work space and eliminated fire hazards when we switched to prepainted strip. But most important, we can custom cut baseboard units to extra long lengths from prepainted coils." Edwards buys .029″ strip lacquered white on one side in 10.500″ and 5.625″ widths; 23″ width, beige lacquered on two sides.



Battery Cans—Nickel Coated Thomas Strip is used by Cly-Del Manufacturing Co., Waterbury, Conn., to produce mercury battery cases for P. R. Mallory Co. Example: RM-502 inner can, drawn by an Eyelet process from 2¼″ by .010″ strip. AK, non-scalloping steel with .000125″ nickel coat both sides must produce can 1.776″ by .506″ O.D. without draw rings, burrs, earing, peeling or flaking. Thomas has supplied nickel coated strip to Cly-Del nearly 20 years. "Precoated strip does this job better than if we plate after forming," says Purchasing Agent Raymond W. Drufva. "There's not much competition for Thomas in nickel coated strip for close tolerance work. It's the only producer able to supply the material we need for these battery cans."

Lipstick Bases—Copper Coated strip means a ⅔ material cost saving for Truelove & Maclean, Inc., Waterbury, Conn., Eyelet stampings specialists. Normally a brass part, a single style of this drawn shell, is produced at rate of 5 million yearly. Firm buys AK, non-scalloping, close gage (±.0005″) copper coated Thomas Strip for ductility, die lubricating and finish plating properties. Co-owners Tom Truelove and Don Maclean say: "We wouldn't attempt some of these jobs unless the material was copper coated steel. Generally it's no harder to work steel than brass when the steel is Thomas Strip's copper coated. There's not much competition for Thomas in this line." (Top photo shows copper coated lipstick bases being packaged with magnetic lifter.)

PATTERN ROLLED STEEL OFFERS UNLIMITED DESIGN OPPORTUNITIES



Home Mailboxes—Pattern Design. The Lady was looking for product appeal. She found it in pattern design sheet from Pittsburgh Steel Co. The Lady is Miss Jeanette L. Troy, director of purchases for The Randall Co. of Cincinnati, Ohio. She explains: "We were trying to find something new for our colonial style home mailboxes—a decorative effect that was different. Pittsburgh Steel's Pattern Design No. 101 gave us the appeal boost we were looking for—and without a proportionate cost boost."

Randall, a division of Textron Inc., produces the boxes for another Textron division, Wagner Manufacturing Co. of Sidney, Ohio. Industrial Engineer Wade Hartman says pattern design sheet saves 50 cents over a mailbox made of similar patterned materials. Rolled-in leather design shows no distortion in forming; permits full thickness of steel to be used in blanking, forming machines. Randall buys pattern sheets in commercial quality .024" thick and in widths 39⅝", 40¼", 42⅞".

Cabinet Hardware—Pattern Design—Thomas Strip's antique patterned steel helps Ajax Hardware Corporation of Los Angeles build strength and beauty into Early American cabinet hardware. President Norman D. Louis says: "Thomas Strip saves many hours by eliminating production steps. The uniformity of appearance, quality and workability of Thomas Strip's patterned steel makes it possible to match Ajax Early American cabinet hardware year after year. Production is fast because of Thomas Strip's close tolerances and formability." Ajax Hardware gives Thomas Strip's uncoated strip an electrolytic coating of rich antique copper or dull black. Photo shows packaging operation.

THOMAS STRIP DIVISION

Pittsburgh Steel Company

Grant Building • Pittsburgh 30, Pennsylvania

Steel

The STEELMARK on a product tells you it is made of steel. Look for it when you buy.

DISTRICT SALES OFFICES

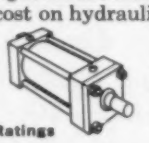
Atlanta	Cleveland	Detroit	Los Angeles	Pittsburgh
Chicago	Dayton	Houston	New York	Tulsa
			Philadelphia	Warren, Ohio

THIS ..IS WHAT YOU BUY!

POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer . . . piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

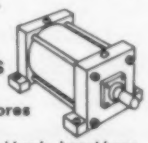
HYDRAULIC CYLINDERS



Two Pressure Ratings

2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½ to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder. Full compliance JIC Hydraulic Specs.

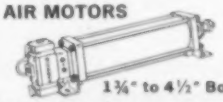
AIR CYLINDERS



1½" to 14" Bores

Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service. Full compliance JIC Pneumatic Specs.

AIR MOTORS



1¾" to 4½" Bores

New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.

HANNIFIN COMPANY

525 South Wolf Road • Des Plaines, Illinois

CENTRAL POINT IN THE NATION FOR FLUID POWER APPLICATION

3128-PH

AMOSOMA

Our on-the-job services make your job easier

You can save considerable time and money in getting flexible connectors best suited to your needs by utilizing the sales engineer consulting services of Anaconda Metal Hose Division.

We are specialists in designing and producing flexible connectors to meet problems of expansion, contraction, movement, vibration, corrosion, pressures, and temperatures. We have broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon*. Our specially trained men will come to you. This is how our services work:

You let us know your flexible connector needs—with conditions, dimensions, and such sketches or drawings as might be necessary for us to understand the problems.

We will work out design problems with your engineers and draftsmen.

We will make specialists available for immediate service calls on equipment or field installations.

We will follow through from original design to finished product.

Our specialists are available to you through Anaconda Metal Hose representatives in leading cities—see the listing "Hose-Metal" in the Yellow Pages. Or write direct: Anaconda Metal Hose, P.O. Box 791, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

*Registered trademark for DuPont fluorocarbon resins. 60124L

ANACONDA®
METAL HOSE

PRODUCT ENGINEERING HORIZONS

SEPTEMBER 19, 1960

THE DECLINE OF CUT-AND-TRY

"For nearly a century, the American scene has been characterized by a shortage of scientific personnel and a relative plenty of materials. Consequently, much of American development in manufacturing has been brought about by trial and-error methods . . . this approach was effective and appeared to be economical, with the result that the 'cut-and-try' approach has become the dominant and traditional mode of operation. . .

". . . this 'American method' has been quite successful in the past, but it is also wasteful of both materials and man-hours of human effort. The waste in personnel arises out of the fact that the same basic problems must be solved, or partially solved, many times over because previous solutions are recorded only as experience in the minds of people."

This quotation, from an unpublished report by Prof L V Colwell of the University of Michigan, points up a basic difference in European and American approaches to technical problems. In basic research on materials, we are at least equal to Europe, but not on any of the subsequent steps from idea to product. Why not? Too much "Yankee ingenuity"?

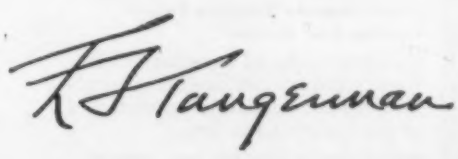
I can recall endless examples of the "little black book" approach, in which engineer or foreman felt some data developed through the years were his personal possessions. He doled out essential figures as carefully as he might frankincense or myrrh in the days before Chanel No. 5. In a significant number of cases, the data were wrong—or at least not the best available; they were the result of cut-and-try with limited means and a limited number of tests *at that particular plant*. Because, along with every "little black book" there seems to go a little closed mind.

The attitude is changing here, but the question is whether it is changing with sufficient speed to enable us to keep up. In too many fields, the distinction between our products and European or Asiatic ones is not the one we prate about—cost of labor. It's in quality of product, quality of design. And foreign design is not based on cut-and-try, which just isn't good enough any longer, but on research, even though overseas funds for research are much more restricted than ours.

Says Prof Colwell, after eight months of study in Europe: "It is obvious that the United States has lost its European market for machine tools except for some gear-cutting machines and a few special types of automation equipment. Even American gear-cutting machines are rapidly being displaced by those of German design . . . most of the credit goes to superior quality, since quality, not cost, determines the relative success of machine tools in the market."

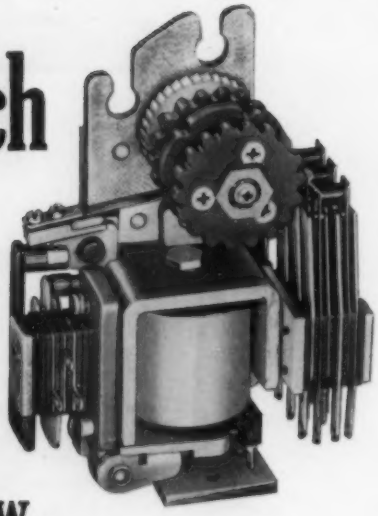
The same holds for watches, instruments, precision measuring devices, machinery and most capital goods. It seems even to have its effect in cameras, automobiles, radio, record players and other consumer items where the purchaser is conscious of quality in results.

Isn't it time our designers and manufacturers became conscious of quality too?



←CIRCLE 62 ON READER SERVICE CARD

Here's a Memory Switch You Won't Forget...



the New CLARE CAM-OPERATED type 200

offers a program control unit in reduced space and with simpler wiring. Actuating cams can be cut with a sequence of notches and lobes programmed to meet the contact switching desired. In addition, the Type 200 acts as a memory switch of unusual dependability and long life.

Operating life is measured in millions of steps. Over 30,000,000 operations have been logged with two cams and a 36-tooth ratchet; 10,000,000 with eight cams. Models are available with from 1 to 8 cams. Operating speed is 60 sps, self-interrupted, 30 sps, remote-impulsed.

The Type 200, as are all CLARE stepping switches, is available with a wide variety of hermetically sealed enclosures or dust covers to insure precise operation under all conditions.

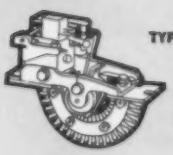
Production quantities available in late fall. Send for Bulletin CPC-7

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P. O. Box 134, Downsview, Ontario. Cable Address: CLARELAY

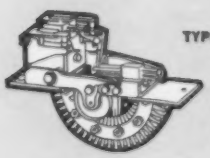
A FULL LINE OF CLARE STEPPING SWITCHES WITH MANY IMPROVED FEATURES

TYPE 210
Has 10 points, with as many as 120 contacts in twelve 10-point levels or four 30-point levels.

TYPE 211
Offers up to 132 contact points on twelve 11-point levels or four 33-point levels.



TYPE 20
Up to 480 contact points in twelve 40-point levels or 320 in sixteen 20-point levels.



TYPE 26
Up to 624 contact points in twelve 52-point levels or 416 in sixteen 26-point levels.

DIRECT DRIVE
Up to three 10-point levels, plus an off position.

new!

Most complete Stepping Switch Catalog ever offered!

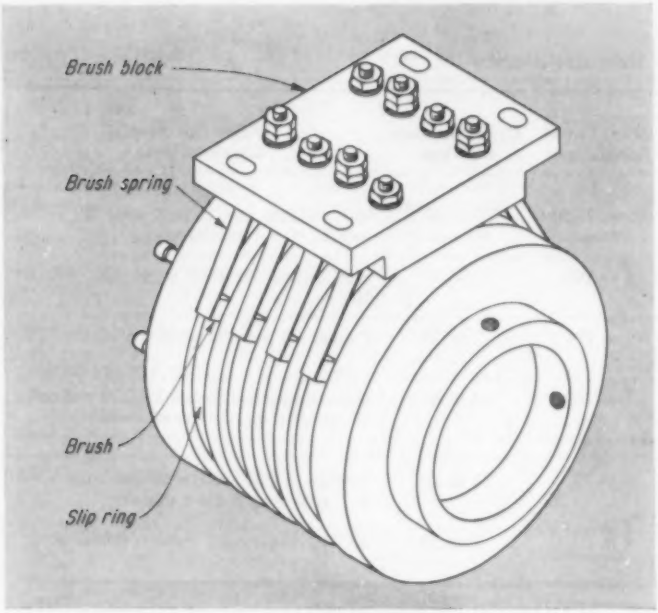
Complete data on construction features, circuitry, performance characteristics and application advantages of the entire CLARE line.

SEND FOR CATALOG 202 TODAY

CLARE

Relays and Related Control Components

Circle 64 for Bulletin CPC-7, Circle 204 for catalog 202



THOSE VERSATILE SLIP RINGS

The increased accuracy of this type of electrical pickup has broadened its usefulness for control, testing and pulse-type transmission. Here's selection procedure, with tables leading you to the best choice of brush-and-ring assembly.

GEORGE MERKER, *chief engineer*
Electro Tec Corp, South Hackensack, NJ

Do you need an electrical link between a rotating and a stationary member? It might pay to take an extra look at slip rings and brushes. Recent developments in materials and manufacturing methods have improved these sliding contacts to the point where they can be as accurate as the precision instruments with which they are used.

CHOOSE RIGHT TYPE—EARLY

If slip rings suit your purpose, the next question is: Which type? The choice of materials and dimensions depends on such parameters as velocity of the rotating member, power to be conducted, and diameter of the rings. (See tables on next two pages.)

Be sure to investigate these parameters early in the design process. If you wait until the final stages, available space may be limited; this can mean much time wasted on making compromises to get the performance needed. Furthermore, the earlier you make the preliminary choices, the more time the supplier will have to suggest possible ways of cutting costs.

WHAT THEY CAN DO

Most slip rings are custom-designed. The illustration above shows a typical brush-and-ring assembly. They come in a wide range of sizes, with from 1 to 600 rings, and serve these three main functions:

For automatic or remote control of mechanical functions, such as temperature or speed control of rotating machinery. An example of remote control is the push-button shift that was mounted in the steering-wheel hub of the Edsel automobile. Slip rings can transmit signals to and from shafts rotating up to 20,000 rpm.

As a design tool, slip rings provide an efficient, economical link between rotary and stationary members in strain-gage instrumentation. They transmit measurements of the strain that is caused by heat flow, thermal shock, vibration and many other conditions that cannot be fully predicted mathematically. They can also be teamed with strain gages to form a safety device that continuously monitors rotating parts.

In a precision commutator, slip rings, in conjunction with a segmented ring, can be used for pulse generation or sequential scanning, as an indexing selector switch, or even as a substitute for a cam, just by varying the length and position of the segments. Transmitted pulses can be any shape—square, sinusoidal, etc.—or any length within the limits of rotational speed.

continued, next page

Table I—Application Requirements

Application	Usual Speed Range, rpm	Usual Number of Rings	Major Electrical Characteristics
Strain gage or thermocouple	100 to 25,000	10 to 50	Low voltage, low current, noise 50 microvolts to 10 mv maximum
Power transmission	1 to 300	2 to 20	High current (to 3000 amp) 220, 440, or 600 v
Power for instruments (relays, switches, etc.)	1 to 100	2 to 10	Current—5 amp max, voltage usually 115
Signal for instruments	1 to 100	4 to 60	Low voltage, low current (to 100 ma) noise 50 μv to 10 mv; may need shielding
Special applications high voltage	1 to 10	50 to 300	Voltage to 3000 v, low current: from 1 ma to 1 amp; may require shielding
coaxial	1 to 10	2 to 20	30–120 megacycles; requires shielding

USING THE TABLES

Take a look at Table I. Find your application and note the range of speed, size, and electrical characteristics. Be sure you're within these general limits. Next pick out brush and slip-ring materials from Table II.

Table III will give you an idea of the width of the rings and insulation barriers between. The number of rings is determined by the number of circuits. Now you have a rough idea of your requirements to guide you in making specifications.

DESIGNING THE SLIP RING

Although it is the slip-ring manufacturer who actually designs the final assembly to your specifications, a little background information on what he goes through might help you come up with a preliminary design of your own. Here's what to consider:

Mechanical Factors

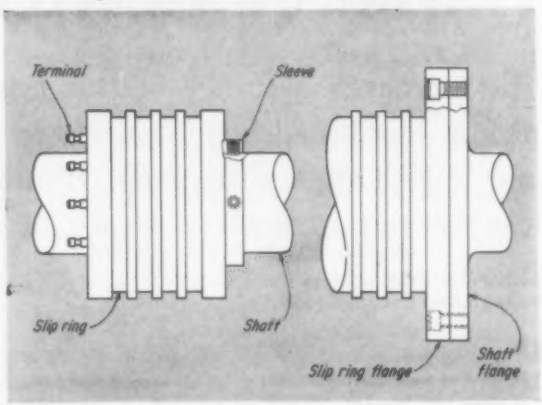
Probably the most important of these is surface speed. Low surface speed—less than 250 feet/min.—presents few problems. High surface speed–from 250 to about 5000 fpm–requires a little more thought. Problems of heat, wear, and noise multiply rapidly as you start to push beyond 5000 fpm. For low speeds, noble metals (gold, silver) work fine. Above 250 fpm, brushes made of silver graphite must be used along with external cooling; and as you approach 5000 fpm, the rings should be extra-wide so that they can double as heat sinks. Above this speed, other brush materials, such as molybdenum fiber, must be tried.

In small assemblies, torque may become important. Static torque on a slip ring can be computed by the equation:

$$T = F \times R \times \mu \times N$$

where T = Torque, oz-in.
F = Force, oz
R = Radius of slip ring, in.
μ = Coefficient of static friction (0.3 to 0.35)

Two ways to mount assembly on shaft



SLEEVE (left), integral with slip rings, is joined to shaft with setscrews. **FLANGES** (right) on shaft and slip-ring assembly are bolted together.

Most configurations are cylindrical but in some cases disk-type slip rings are used. These are mounted on the end of a drum in concentric circles, and should be flat within 0.002 in. per in. of diametral length.

Electrical Factors

These generally determine size and sometimes shape of the slip ring to be used. First, the size of the brush is determined by the amount of current it must carry. Then, the size of the slip ring is calculated, based on an optimum figure of 500 circular mils per ampere (3.93×10^{-4} sq in. per amp). This figure can be varied, of course; here is where compromises are made, if necessary.

The insulation barrier is generally made of epoxy formulations and can be raised above the rings to prevent arcing when voltage or current is high.

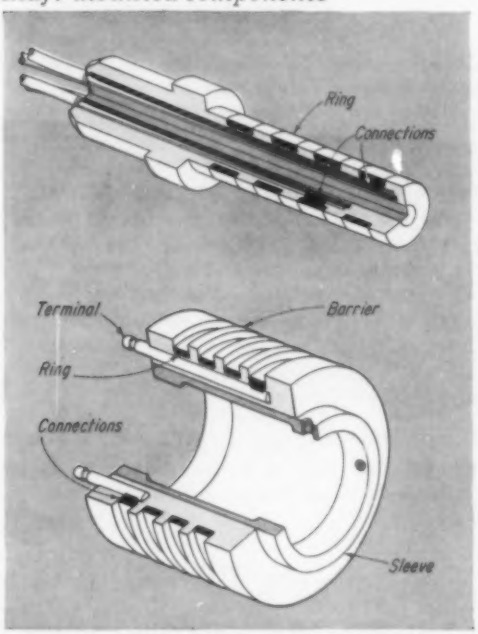
When you are concerned with transmitting signals, rather than power, noise can become an important factor.

Table II—Guide to Materials for Brush and Slip Ring

For these conditions . . .	that have these limitations . . .	These materials give best accuracy		Typical Applications
		Brushes	Slip Rings	
low noise (10 to 50 μv), small rings (⅜ in. dia max)	low velocity (below 250 fpm), low current (below 2 amp)	gold alloy	24-k gold	strain gage, thermocouple
low noise, large rings (over ⅜ in. dia)	low velocity, low current	gold alloy	silver with gold-alloy plate	signal for instruments
low torque (0.1 to 0.5 oz-in.)	low velocity, low current, small rings (⅜ in. dia max)	gold alloy	fine silver with rhodium flash	power for instruments
high velocity (250–5000 fpm*)	none	silver graphite	fine silver	strain gage, thermocouple
high current (above 2 amp)	none	silver graphite	fine silver	power transmission, power for instruments
low velocity, low current	none	gold alloy	fine silver	strain gage, thermocouple

* Special brush materials needed over 5000 fpm.

Two ways to link slip rings and shaft-mounted components



INSIDE SHAFT (top)—wires from rings lead through core of hollow shaft. **OUTSIDE SHAFT** (bottom)—wires follow exterior of solid shaft.

Table III—Widths of Slip Ring and Insulation

Factor	Ring Width, in.	Barrier Width, in.
Velocity		
Above 250 fpm	0.125 (see also current)	0.060
below 250 fpm	0.020	0.030
Current		
above 2 amp	0.125 to 0.500	0.060 to 0.250 (raised or flush)
below 2 amp	0.020 to 0.040	0.030 to 0.060 (raised or flush)
100 amp and up	use rings in parallel to avoid extreme size	
High voltage		
3000 v and up	depends on current	increase width, raise height 1/16 to 1/8 for longer creepage path
High speed	as wide as possible to increase cooling surface	
Low signal, noise and torque (see note)	0.020 to 0.040	0.020 to 0.040

Note. Usually purchased in complete assembly which includes housing and integrally mounted ballbearings.

Noise is an unwanted ac voltage generated by dc passing through slip rings and is caused by change in contact resistance. A noise level of 10 to 30 microvolts for low-speed assemblies is generally acceptable; a level of 50 to 100 microvolts for high-speed assemblies is not unusual.

For most applications, use two brushes per slip ring, especially if you have vibration present. The low-speed brushes, made of noble-metal wires, carry about 40% of the current of equivalent-size copper wire; the silver-graphite brushes carry about 10% (about 300 amps per sq in. continuous). The problem here is the cross-sectional area of spring, which is generally a cantilever made of beryllium copper. This area is smaller than that of the brush, so even though the beryllium-copper can carry double the current of the silver-graphite per unit of area, the spring will generally be pushing its ampere limit. Normal brush force should be 0.10 to 0.18 oz (3 to 5 grams) for the noble-metal brushes, with wire diameters to 0.010 in. and lengths up to ¾ in. For larger wires, force has been as high as 0.88 oz (25 grams). With silver-graphite brushes, pressure usually ranges from 10 to 15 psi (area is usually function of current-carrying capacity of the brush). Life and noise are inversely related, so a compromise must be reached between long life and low noise. ■

a survey of encapsulating systems

The technology of encapsulation is now so broad that you may not know where to start. This article provides an introduction to the subject, plus an up-to-date comparison of the basic systems.

E A SCHATZ, *head*
Plastics R & D Laboratory, Missile Systems Div
Raytheon Co, Bedford, Mass

The demand for greater reliability in machines that depend upon electronic and electrical components is focusing attention on protection by encapsulation. Surrounding these delicate devices and circuits with a plastic encapsulant adds dependability for these reasons:

1. The part or component is shielded from harmful environments like salt spray, oils, fuels, chemical fumes, and even high humidity.

2. Vibration or shock loading from rough handling or surrounding service conditions is easily isolated.

3. Internal heat generated during operation can often be dissipated more easily through carefully designed encapsulants than through still air.

4. Designs can be simplified and made more compact by capitalizing on the mechanical support of the encapsulant.

5. Additional insulation is provided where extra protection against voltage breakdown is required.

6. Steadily improving semiautomatic encapsulating equipment and techniques are producing more-reproducible products at lower cost.

To gain these advantages, however, an encapsulating system requires two elements that must be judiciously combined. First is the material itself, which can be a foam plastic, a solid, a liquid, or—more recently—a gel; second is the application method, which can vary from spraying or dipping to casting or spreading with a spatula.

Each combination of material and method may be considered as one of the four techniques—encapsulation, potting, embedding, or impregnation—defined on the facing page. To simplify the discussion here, the simple term—encapsulation—covers them all.

CHOOSING THE MATERIAL

Most of the resins used in encapsulation are thermosetting materials that cure into cross-linked plastics upon

SOME TERMS YOU SHOULD KNOW

■ Encapsulation, potting, embedding, casting, impregnation—all these are terms often used interchangeably to describe the protection of delicate components by surrounding them with organic materials. Though related to each other, these terms do differ in ways that matter:

Encapsulation is the technique of coating or enveloping a part in a shell-like plastic structure for protection against contaminants as well as against shock and vibration. Usually done by dipping, spraying, or spreading, encapsulation is simplest and least expensive type. The encapsulated part usually retains its original shape.

Potting refers to casting a resin around and throughout a part, located by suitable jigs, within a can or mold that becomes a part of the finished product. Thickness of plastic surrounding the part is greater than with encapsulation, and the method is often employed where vibration and shock must be resisted. The can, or "pot," offers support to rubbery materials as well as a means of mounting.

Embedding signifies the complete removal of all mold parts or cans after the resin is cured. Like potting, it implies a complete flow of resin around and throughout the part being processed, either by gravity feed or under moderate molding pressure. Embedding applications usually require considerable mechanical strength, so the materials specified are most often thermosetting plastics in either rigid or semi-rigid form. **Casting** is the same as embedding, but sometimes implies the use of the lower viscosity, transparent resins like epoxies or polyesters.

Impregnation is the void-free penetration of tightly packed elements of a part by a liquid resin with low viscosity. The process is usually done under vacuum to replace air or gases completely with the resin. It is like encapsulation, except that the organic material intimately surrounds all parts of the structure, instead of covering it by bridging across the outer parts; the coating is also thinner. An example would be the impregnated windings of a transformer coil. ■

Table I—Comparison of Properties: Typical Encapsulating Materials

Material	Linear shrinkage	Thermal expansion	Thermal conductivity	Volume resistivity	Dielectric strength
Epoxy:					
Unfilled	very low—medium	low—high	low—medium	good—excellent	very good
Filled (rigid)	very low—low	low	high	very good—excel.	very good—excel.
Filled (flexible)	low—high	low—high	medium	good—very good	very good
Syntactic	very low—low	very low	very low—low	very good	good
Polyurethane:					
Foam	very low	low—high	very low	very good	(not available)
Cast	very low—high	high	very low	good—very good	good—very good
Polyester:					
Filled (rigid)	med.—very high	low—high	medium	good—very good	very good
Filled (flexible)	med.—very high	high	medium	good	good—very good
Silicone:					
Cast (filled)	low	high	very high	excellent	good
RTV rubber	high	very high	medium	very good	very good
Gel	very low	very high	medium	excellent	excellent
Polysulfide rubber	very high	(——)	(——)	good	good
Alkyd (molded)	low—medium	very low—high	high—very high	very good	good—very good
Vinyl plastisol (filled)	med.—very high	high—very high	low	good—very good	good—excellent

Key to Ranges in Table I

LINEAR SHRINKAGE, (in./in.): very low <0.002; low 0.0021—0.004; medium 0,0041—0.010; high 0.0101—0.020; very high >0.0201.

THERMAL EXPANSION, (in./in./°C) $\times 10^{-5}$: very low <2.0; low 2.1—5.0; high 5.1—10; very high >10.1 (figures were referenced against aluminum).

THERMAL CONDUCTIVITY, (cal/sec/sq cm/°C per cm) $\times 10^{-4}$: very low <1.5; low 1.6—4.0; medium 4.1—9.0; high 9.1—20; very high >20.1.

VOLUME RESISTIVITY, (ohm-cm): good 10^{11}—10^{13}; very good 10^{13}—10^{15}; excellent 10^{15}—10^{17}.

DIELECTRIC STRENGTH, (volt/mil): good 225—399; very good 400—500; excellent >500.

application of heat or catalysis. The properties of the more common types are compared in Table I, which also includes vinyl plastisols. This is a simplified comparison since it presents properties in ranges to cover a vast number of commercial and laboratory formulations. Despite this, the table provides a useful screening guide for preliminary selection.

Variation of formulation, as well as filler type and its concentration, accounts for the listed property ranges. For example, fillers will improve thermal conductivity and reduce shrinkage and thermal expansion coefficient as compared to the unfilled resin. In addition, the table does not show cure cycles and relative processing time for the different materials—both are important factors in achieving lowest cost when two or more materials offer similar performance.

Temperature limitations exist for these materials, and vendor technical literature is the surest way to establish them. Such literature, along with technical papers and articles, must be studied carefully by anyone considering encapsulation. A vast majority of the companies who have used these techniques for a long time use commercial two-component ready-mixes for the majority of applications. A good many of these same firms do some formulation of their own compounds, however.

APPLICATION METHODS

Method of application can be as important to reliability as selection of the encapsulant itself. Not all materials can be processed by all the methods now in use, and often properties of the material must be compromised with methods to obtain reasonable production costs. No designer working in close tolerances needs feel incompetent when he marks his print "Design approval subject

to first-lot inspection" because there will always be two or three systems—material plus methods—that appear to be the right solution.

Table II, on page 72, will assist in the selection. It compares the major systems of encapsulating that use organic materials. For each application method are listed the plastics that can be used with that method, and whether the material is available in rigid, semirigid or flexible form. Each system is described briefly—with its advantages and limitations—to show the broad range of solutions available and to help weed out the less feasible ones. Tables I and II should be used together: select suitable materials from Table I and check the various methods for encapsulating with them in Table II. Or, if processing considerations predominate, the procedure can be easily reversed. When one or two systems have been tentatively selected, the encapsulating specialist (often a materials vendor) can be consulted.

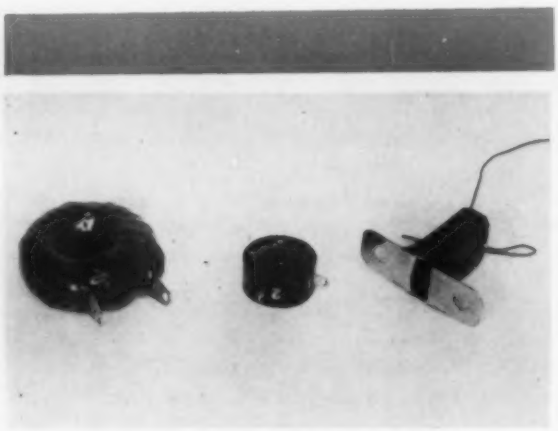
DESIGN PROBLEMS

Beyond the selection of end properties and processing technique, these problems relating to the nature of curable encapsulants must be weighed:

Shrinkage is the most important of these. Organic materials shrink a measurable amount when polymerized or cured. For some compounded encapsulants, this may run as low as 0.0005 in./in. to as much as 0.020 in./in. and greater, depending on the curing agent used, how the resin is filled and processed. Severe shrinkage can have several adverse effects: Unattractive surface depressions (sink marks) may appear at points where the resin is free to shrink most, individual parts within a multiple-part embedment may be shifted about, external dimensions cannot be held to close tolerances, pressure-sensitive parts can be easily crushed, or the resin itself may crack in shrinking against a rigid part.

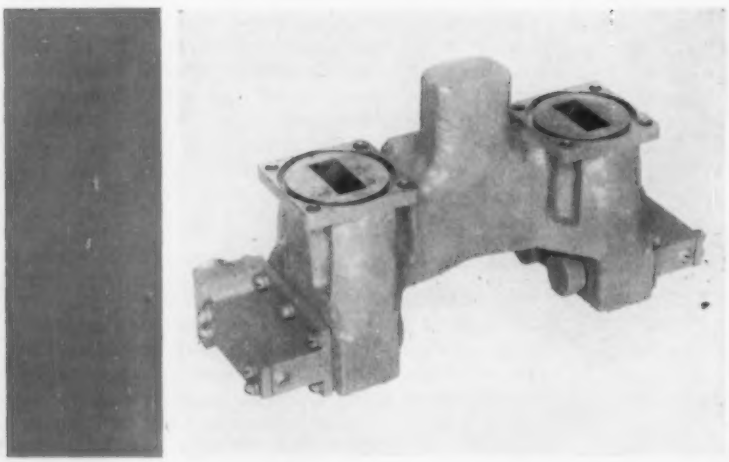
Encapsulating materials may be roughly screened for best shrinkage by encapsulating a short length of steel hex bar stock in a measured amount of resin, as described in ASTM Test Method D1674-59T. Or a dummy shape may be cast in place. Shrinkage problems can be controlled by filler addition to reduce shrinkage, or by selecting a semi-rigid or flexible encapsulant which will give during cure.

Thermal effects are another serious problem. Polymerizing plastics generate internal heat which may damage



THREE METHODS of encapsulation for small components are compared here. Left: dip-coated toroidal winding uses thixotropic epoxy resin that conforms closely to winding shape. Center: embedded winding gets its cylindrical shape and anti-rotating pin by injecting epoxy encapsulant into machined mold. Right: dual capacitor is embedded by casting epoxy resin around it—the mounting plate serves as a fixture for centering in the mold.

COMBINING ENCAPSULATING SYSTEMS does several jobs in one assembly. Circuitry for the subsystem package shown on next page has several resistors and capacitors above the mounting board. These were supported against vibration by "fillets" of semi-rigid epoxy. With tubes in place, a thin room-temperature vulcanizing silicone skin was spread over tubes and their clips to keep the tubes from shattering under vibation. Entire assembly was then coated with a transparent, highly insulative epoxy for moisture resistance.



DAMPING VIBRATIONS out of large surfaces can improve performance of many precision devices like waveguide component at left. A thick coating of water-thinned Aquaplas was sufficient to reduce natural vibration frequency of the structure well below the operating frequency. Moisture resistance was achieved with a top coating of epoxy resin.

ROUGH HANDLING of prepackaged electronic instruments is prevented with thick blanket of vinyl plastisol. Instrument box was dipped several times in plastisol to build up adequate thickness, then carved like a Halloween pumpkin to provide access openings for cables, dials and repairs.

the part being encapsulated. Plastics vary markedly in this exothermic effect, depending on the curing agent and curing cycles. External heat required for cure may be too high for the part.

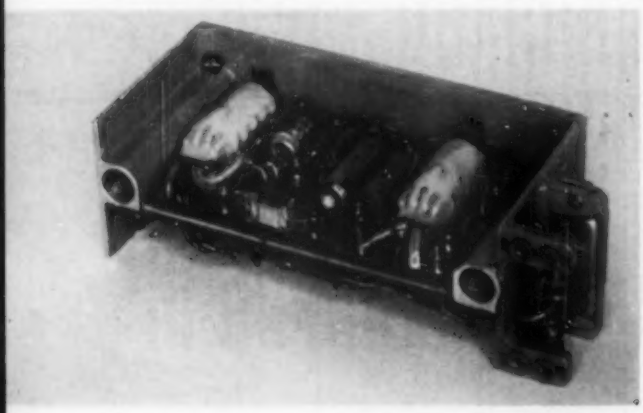
Assuming a part has been successfully encapsulated, if the two materials do not change dimension at similar rates as temperature changes, especially on cold cycling, the part can be crushed or the resin cracked. A reasonable match in thermal expansion coefficients will help here. Where these are not known, or where points of stress concentration exist, a simple thermal shock test like that contained in ASTM Method D1674-59T will screen out unsuitable encapsulants. Here, a short length of steel hex bar stock is encapsulated and is cycled thermally. A "satisfactory" material is one that will take 10 cycles without cracking, four samples out of five. If thermal coefficients cannot be matched, a flexible or a semirigid encapsulant is a good choice.

Heat generated by the encapsulated component itself should be checked carefully. Compared with metals, plastics are not good conductors of heat—though some are much better than others (Table I). If high heat dissipation is required, then a high-conductivity material should be selected and applied in as thin a layer as possible. Heat sinks, in the form of metal rods, may have to be brought in from the sides of the package to the principle source of heat. Temperature-time exposure effects on the package may have to be determined empirically because plastics can take surprisingly high temperatures for brief periods.

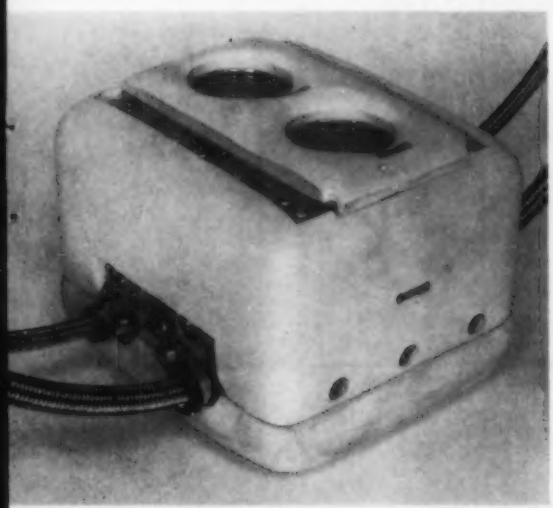
Surface finish of the finished embedment is not a factor that influences performance, but is taken by customers as an indicator of technical competency. An encapsulating job may be sounder than its competitors technically, but if it looks like a "bench job" the customer may reject it. Mold finish is the key to better product finish for parts that use embedding as the method of application (see "Some Terms You Should Know," p 68, or Table II, p 72 for more process details).

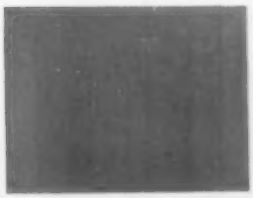
Close fit-up of mold parts will reduce parting-line flash, particularly when the lower viscosity resins are used. Dipping, spraying and fluidized bed coating (Table II) are other encapsulating methods that will generate smooth, continuous surfaces. Special care should be given sharp edges or corners when dipping or spraying, because film thickness at these points is minimal.

text continued on p 74



A GRIPPING SURFACE plus spring action helps this clip secure electron tubes against vibration damage. Tines of the clip are coated with a vinyl plastisol dip-and-fusion technique. Coating also provides increased voltage resistance to entire support assembly.



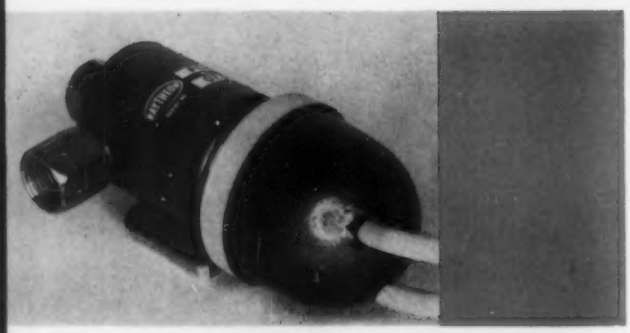


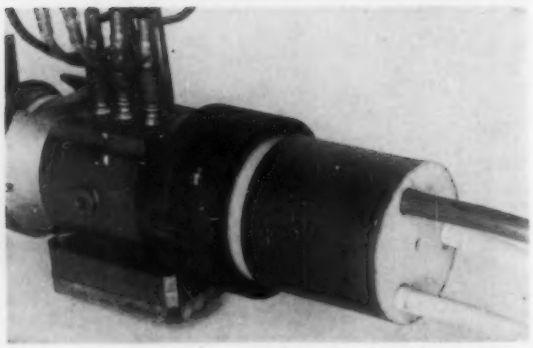
THICK CUSHION of room-temperature vulcanizing (RTV) silicone rubber surrounds delicate mechanism of this radar frequency component. RTV was chosen because high curing temperature of other encapsulants would damage the device; also, the rubber will withstand rough handling in the field. Four dots at top of casting are traces of holes in the mold to provide for overflow during pouring of the resin.

Table II—Comparison of Encapsulating Systems

Encapsulant Type	Application Method	Materials Used	System Description	Advantages	Limitations	Typical Applications
FOAMED RESIN	Poured into mold or injected by low-pressure gun	Polyurethane Rigid (R) Semirigid (SR) Flexible (F) Silicone (F)	Liquid system, usually having two components. After short mixing period, mixture is placed in mold and foams to fill volume. Post-curing gives best properties.	Processing relatively easy. Foam is lightweight, moisture-resistant if unicellular, and can be engineered by formulation. Foam also assists other supports for the component being embedded.	Mold must be used (to give non-porous outer skin) if container in which foam is produced does not become part of finished product. Foam has low thermal conductivity, thus embedded part must withstand heat of curing and/or heat of operation. (Here, heat sinks will help.) Load-distributing inserts required for mounting unsupported foam after embedment.	"Black boxes" for telemetering systems and miniature computer components where low weight and shock resistance are required.
	Expandable beads poured into mold	Epoxy (R)	A single-component system. Heat-sensitive beads, with an occluded-gas blowing agent, are poured into mold and heated—forming foam to fill volume.			
	Packed into mold	Epoxy resin filled with tiny, hollow glass or plastic sphere (syntactic foam)	A two-component system. Glass or phenolic spheres are mixed into catalyzed resin to the consistency of wet sand. (Ready-mixed systems also available.) After packing mold to full volume, mix is heat-cured, with very little dimension change.	Strength/weight ratio better than that of solid resins. Thermal conductivity higher than that of most foams. Some formulations can be drilled and tapped for mounting, if necessary. Very low shrinkage.	Uniform density difficult to achieve with more fluid mixtures. Air bubbles must be evacuated in more liquid mixtures (heating will lower viscosity if hardener provides enough pot life). Machined surfaces cannot be buffed to high gloss because of reinforcing spheres.	Encapsulation of electronic modules containing capacitors, resistors, transistors, and diodes.
LIQUID	Poured into leaktight shell	Silicone	A single-component system. Liquid is poured into permanent shell, evacuated to remove air. Shell is sealed after pouring.	Provides good damping against vibration, and good thermal stability. Available in wide vicsosity range.	Requires sealable container that will not leak in service. Thermal volume changes require compensating bellows.	Encapsulation of gyros accelerometers, and other shock-sensitive devices.
GEL	Poured into leaktight shell	Silicone	Two components are mixed, evacuated for air removal and poured into shell. Heat cure sets up liquid to firm gel state.	Gel has good damping properties, high moisture resistance, good dielectric strength, is transparent. Self-sealing characteristic makes repairs easy; material can be sliced open or removed and replaced.	Gel not self-supporting, requires outer shell. Some materials occasionally inhibit cure of gel.	Potting of high-voltage electronic assemblies.
SOLID RESIN	Poured into mold or injected by low-pressure gun	Epoxy (R, SR, F) Polyester (R, SR, F) Polysulfide (R, SR, F) RTV Silicone rubbers (F) Polyurethane (SR, F) Silicone (R)	Usually two-component systems, evacuated to remove air, poured into mold and re-evacuated. Highly viscose systems can be gun-injected. Mix is heat-cured. Some single-component systems are available.	Materials have good strength, and resistance to moisture, chemicals, electrical and thermal shock—depending on hardeners and fillers chosen. Rigid types easily machined, drilled and tapped for mounting.	Internal heat of curing may be too high for some sensitive parts. Shrinkage can be high, particularly for polyesters and acrylics. Urethanes react with moisture, require careful processing. Silicone surfaces inhibited by air during cure if not covered.	Encapsulation or potting of coils, windings, transformers, chokes, resistors and modules composed of capacitors, resistors, transistors and diodes. Flexible type used in potting cable connectors.
	Centrifugally cast	Polyurethane (SR, F) Epoxy (R, SR, F)	A two-component system is mixed and poured into multiple molds mounted on turntable arrangement. Spinning provides centrifugal force to push resin into all parts of molds. Component being potted is usually heated to drive off moisture. External heat applied during spin-cure.	Pressure created by spinning liquid resin gives several advantages: No evacuation is necessary. Resin fills all details of mold, including hard-to-reach, thin sections. Resin shrinkage is low. Air bubbles not trapped in resin.	Filler can separate from resin unless spin rate is chosen to be compatible with filler specific gravity. Balance of rotating system is critical. Molds or potting containers must be very leaktight.	Potting of coils, winding transformers, etc.

SOLID RESIN (Cont.)	Pellets poured into molded plastic shell	Epoxy (R, SR, F)	A one-component system. Epoxy pellets are packed around component to be embedded after it has been located with the epoxy shell with suitable fixtures. Heat fuses filler and shell together.	Material is dry, has but one component, and presents no pot-life problems. Amount placed in mold is easily controlled. Process is simple and not messy.	Requires external shell or case as an additional expense. Pellets must be kept dry.	Potting of coils, transformers, resistors, diodes and semiconductors.
	Compression-molded	Alkyd (R) Polyester (R)	A one-component system, in either putty-like or granular form, is placed in mold around component and cured under heat and pressure.	Finish is smooth and void-free. Dimensions reproducible within close tolerance. Electrical leads easily located to close tolerance. Withstands high temperature.	Components that cannot withstand molding temperatures and pressures cannot be encapsulated.	Coils, resistors, and capacitors.
	Spread with spatula	Epoxy (R, SR, F)	Usually a two-component, thixotropic system that, when mixed, will stay in its as-spread condition without flowing even though cured by heat. Some single-component systems available.	Molds are not necessary since resin mix will not sag or run. Fast production cycles are possible.	Air bubbles hard to remove even after heating and evacuation; some reappear during spreading. Precise outer dimensions cannot be held. For this, material must be overpacked, and machined off.	Encapsulation of wound coils, transistors, and other components of a geometrical symmetrical shape.
	Dip-coated	Epoxy (R, SR, F)	A two-component, high-viscosity, system is mixed and evacuated. Part to be encapsulated is heated to curing temperature, dipped into mix, and removed. Coating cured with heat.	Surfaces are smoother than for spread resins. Air bubbles not such a problem. Machining not required as coating is thin.	Areas like mounting surfaces must be masked. Thick areas hard to build up as in spread coatings unless dipped repeatedly. Resin must be evacuated.	Impregnation of transformers, chokes, coils or any component of nonsymmetrical shape.
	Spray-coated	Epoxy (SR, F) Polyurethane (SR, F) Silicone (SR)	A two-component system is mixed and sprayed. Some systems contain solvents so spraying viscosity can be adjusted. Cured with heat.	Same as for dip-coated surface, except coating is thin enough to spray—permitting a fast production cycle.	Masking required. Thickness limited to 1/16 in. and under. Special spray gun sometimes needed for short-pot-life materials. Cleaning time required.	Encapsulation of printed circuit panels or flat component packages requiring somewhat flexible and/or tough coating for vibration protection.
	Fused coatings: (1) Dipped or sprayed	Vinyl plastisol (SR, F)	A one-component system. Part is heated to fusion temperature of plastisol (300–375 F) and then coated. Warm part fuses vinyl in plastisol into a homogeneous coating.	Tough, resilient rubberlike coating can be built up to ½ in. thick or under; dipping specified for thickest coatings. Good thermal and shock resistance. Excellent moisture resistance. Can be machined by freezing.	Primer must be used for adhesion. Coatings must not be used near solvents that swell or harden vinyl. Part must be able to take fusion temperature. Masking required.	Coating of parts like switches that need good electrical insulation and abrasion resistance; mounting clips for holding cylindrical parts against vibration.
	(2) Fluidized	Vinyl Polyethylene Polyamide Epoxy (All SR, F)	A one-component system consisting of specially formed and carefully sized material particles, kept in constant buoyant agitation by gas flow. Part is heated above melting point of fluidized powder and inserted in bed. Residual heat fuses coating on removal.	Thick or thin coatings can be made in a single dip. Inner recesses can be coated. Corner and edge coverages as good as for flat surfaces.	Process variables require close control. Special equipment required. Maintaining adhesion, uniform thickness, and pore-free surface occasionally is a problem.	Encapsulating boxed items like toroidal cores.
	Air-dried coatings	Aquaplas (R)	A one-component, water-soluble system. Mix is either trowelled in place (for heavy thicknesses) or thinned and sprayed on (for thicknesses up to ¼ in.), then heated to dry state.	Excellent damping coating for large unsupported surfaces. Fairly hard, non-tacky surface when all solvent is dissipated.	Smooth surfaces hard to achieve, except by spraying. Special large-orifice spray guns required. Softens in high humidity or water contact unless protected with epoxy. Slow for thick sections.	Coating of waveguide and guide junctions where microphonics must be reduced for operation; panels that carry components but require damping.





TWO WAYS TO SUPPORT WIRING LEADS under conditions of high temperature and high voltage are shown in these magnetron designs. Unit at top has its leads potted into a hemispherical molding of high-density syntactic epoxy foam; pinholes between the leads are tiny glass spheres that broke open at the surface. At bottom: experimental magnetron tube has its leads potted with RTV silicone rubber contained by a silicone-glass laminate shell. Space is allowed within the shell for thermal expansion of the rubber potting material, and hole in the cover allows air to escape from the shell as this expansion occurs.

PRODUCIBILITY PROBLEMS

The detailed procedures within each of the methods of encapsulation outlined in Table II fall into the category of "know-how" and are adequately and continuously covered in papers and articles (see Editor's Note) to be found in any engineering index. Vendor's literature is also a fruitful source of tips, and imagination plus common sense will supply many more. There are a few suggestions about product problems, however, that are appropriate in an introductory article of this type:

Foamed plastics require special care to ensure that all parts of the mold are filled. Judicious positioning of vent holes, usually placed at the high points of the mold, will allow air to be expelled and replaced by foam. As one section of the mold fills, its vent holes can be closed off, forcing the foam to these remaining areas. Foams generate considerable pressure which the mold must be designed to withstand. They also tend to adhere tenaciously to metal surfaces, so if the mold is not intended to become a part of the finished product, a good mold release must be selected. Higher density of most foams at the surface (next to the mold) usually result in a continuous, almost solid "skin"—a definite reliability advantage where the package will receive some rough handling.

For encapsulation systems that require reusable molds, assembly and disassembly labor costs can make or break the design. Such molds should be constructed to come apart easily, yet be close fitting enough to retain low-viscosity casting resins so well that hand sealing is not required each time the mold is used.

High-viscosity encapsulants like the polysulfides and some silicone rubbers may require an air-actuated injection gun to force the resin into the mold from the bottom. Small vent holes are necessary in these cases to get the slow-moving material into all parts of the mold.

Air-evacuation of the mold may be required on some jobs to fill all portions of a complex mold or to completely impregnate all portions of the item being encapsulated. Evacuation also speeds up the entire cycle and is therefore incorporated into most semiautomatic equipment designed to reduce production costs in high-volume applications.

Toxicity can be a problem with most encapsulants, either with the resins and curing agents, or with the associated chemicals—release agents, diluents, cleanup chemicals, fillers, pigments, etc. This question has been most carefully studied by the materials suppliers and companies experienced in encapsulation. Accordingly, the literature has much good advice on safe handling procedures, personnel protection, cleanup precautions, ventilation systems, employe education and the like.

REPRINT COPIES of this report are available for 25 cents each by addressing Reader Service Dept., Product Engineering, 330 W 42nd St, New York 36, N. Y.

EDITOR'S NOTE: Recent articles that present greater detail on many of the materials and techniques discussed above include:

Epoxy Parts Cast by Centrifugal Force, May 23 '60, p 45—How to make precision parts in quantities that don't justify the high tooling cost of injection molding.

Cast Epoxy Models, Dec 21 '59, p 60—Convert your new-product ideas quickly and directly into actual parts or assemblies, allowing simultaneous appraisal of many designs.

Which Vinyl Coating Process for Metal Parts? July 6 '59, p 70—Comparison of the three basic methods for coating preformed parts. A fourth process—laminated film—is included to extend the comparison to postformed parts.

Epoxy Castings, June '57, p 135—Shows the advantages of epoxies compared to other casting resins, and give details on proper design for large parts that can be made in low production quantities at low cost in no other way.

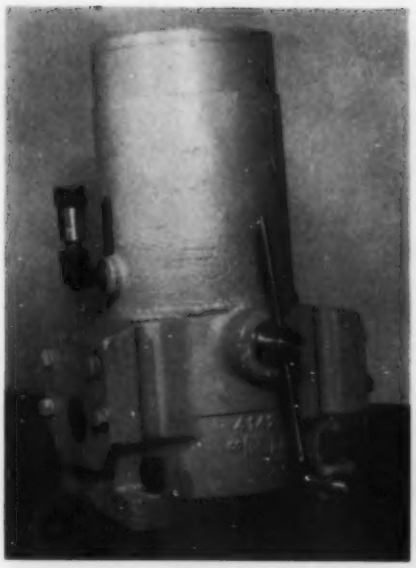
New Foamed Silicones Give Hi-temp Insulation, Jan 5 '59, p 50—Here are first data on the latest rigid, semirigid, and flexible self-curing silicones.

Best Recipe for Casting Urethane Foam, Nov 10 '58, p 86—Covers latest details on cavity design, formula choice, production controls to get the most out of strong, lightweight parts made from rigid polyurethane foams.

Molded Silicone Rubber Parts, April 14 '58, p 69—A detailed discussion on best design practice including geometry, cure cycles, metal inserts, marking, and testing. Material properties summarized for various grades.

Cast Urethane Rubber, Sep 16 '57, p 68—Gives properties, performance features, and design guides for an exceptionally abrasion-resistant elastomer developed in Germany.

Fluidized Plastic Coatings for Corrosion Resistance, Jan '57, p 140—Explains the basic powder-dip process and which variables are important to coating performance. Included are details on coating materials available and cost factors.



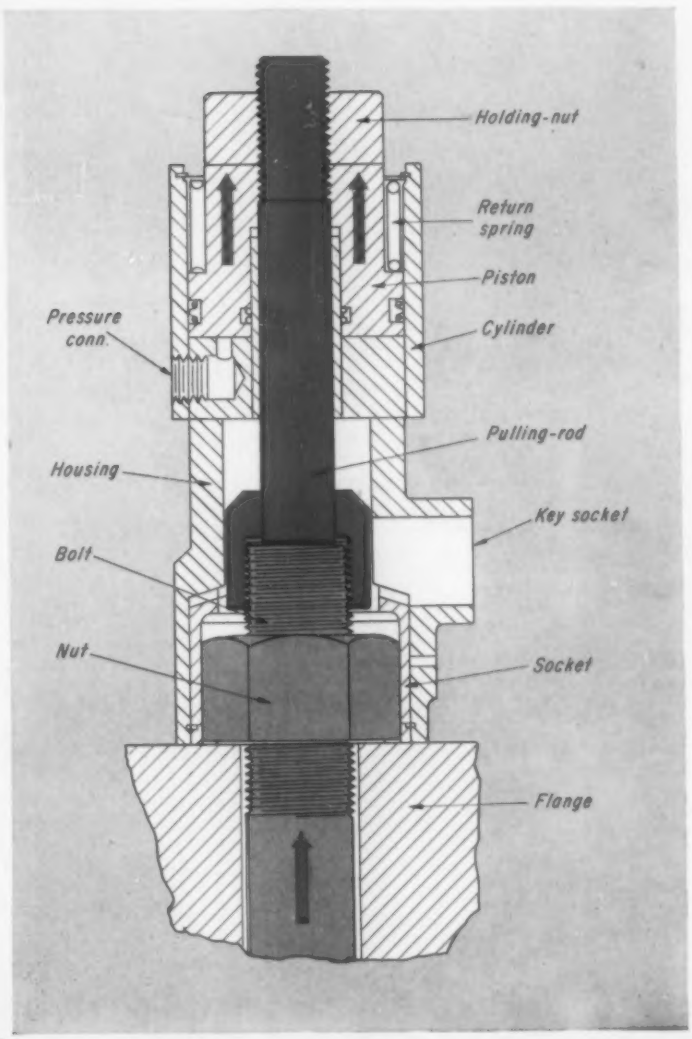
HYDRAULIC TENSIONER is positioned, then pulling-rod is screwed down over the portion of the bolt extending through the nut. Rod must engage a length equaling at least ¾ of bolt diameter. When pressure is applied by hydraulic-actuated piston against the holding nut, the result is tension in both pulling-rod and bolt. The compression reacting to this force is relayed to the flange by the support housing. This lifts nut away from flange.

Next, a key is used to rotate the nut socket, turning the nut until it is seated on the flange. Now, when hydraulic pressure is released, the predetermined load is transferred to the stud-and-nut assembly. Preload calculation must include a 20% overload to offset the loss occurring when nut takes the load from the tensioner. For uniform closing, three or more tensioners must be used simultaneously.

PS . . . Controlled bolt-loading is achieved by exerting a predetermined load on a stud or bolt and reading the tension on a gage. Preloading eliminates galling, since there is no relative motion between mating parts. Commercial accuracies of ±10% can be expected; finer tolerances if required. Tensioners for bolts up to 6 in. dia, with a total pull of 1,375,000 lb, are produced by Biach Industries Inc, Cranford, NJ.

Bolts Stretched for Tight Fit

This hydraulic tensioner tightly seats pressure covers. Preloading the bolts eliminates seizing or galling.



special chart leads you to

FOUR-BAR LINKAGE PROPORTIONS

PREBEN W JENSEN
Remington Rand Div, Sperry Rand Corp
South Norwalk, Conn

Given two points, a function of the length of stroke you want, this handy chart quickly and accurately locates the other two. You find the proportions of all four bars without cumbersome mathematical or graphical methods.

ABOUT THE AUTHOR

Preben W. Jensen received his degree in Mechanical Engineering in 1955 at Copenhagen, Denmark. He worked and studied for several years under Profs Kuhlekamp and Kraus in Germany, where he became familiar with Dr Kurt Rauh, who set up the nomograph method described here. Jensen has specialized in high-speed mechanisms and has published articles on cams and linkages in Denmark and Germany.

Proportions of 4-bar linkages for straight-line motions are usually determined by graphical methods. Then, the precision points in the required straight line are checked by mathematical methods, where necessary. But graphical methods, although simpler than a purely mathematical solution, can be quite complicated. The late Dr Kurt Rauh, professor of kinematics at the Technical Institute, Aachen, Germany, conceived the chart shown on next page, which simplifies graphical determination.

The chart is based on two circles, one having twice the diameter of the other. The smaller, called the Cardan circle, rotates inside the larger one; at the same time the center of the Cardan circle serves as a hub around which all of the space on the chart radiates.

Fig 2, p 79, shows the behavior of typical points on the chart during this rotation. The center, M, of the Cardan circle, describes a circular path around center, W, of the large circle; all points on the circumference of the Cardan circle describe straight-line paths at different angles through W. All other points, whether inside or outside the Cardan circle, describe elliptical paths.

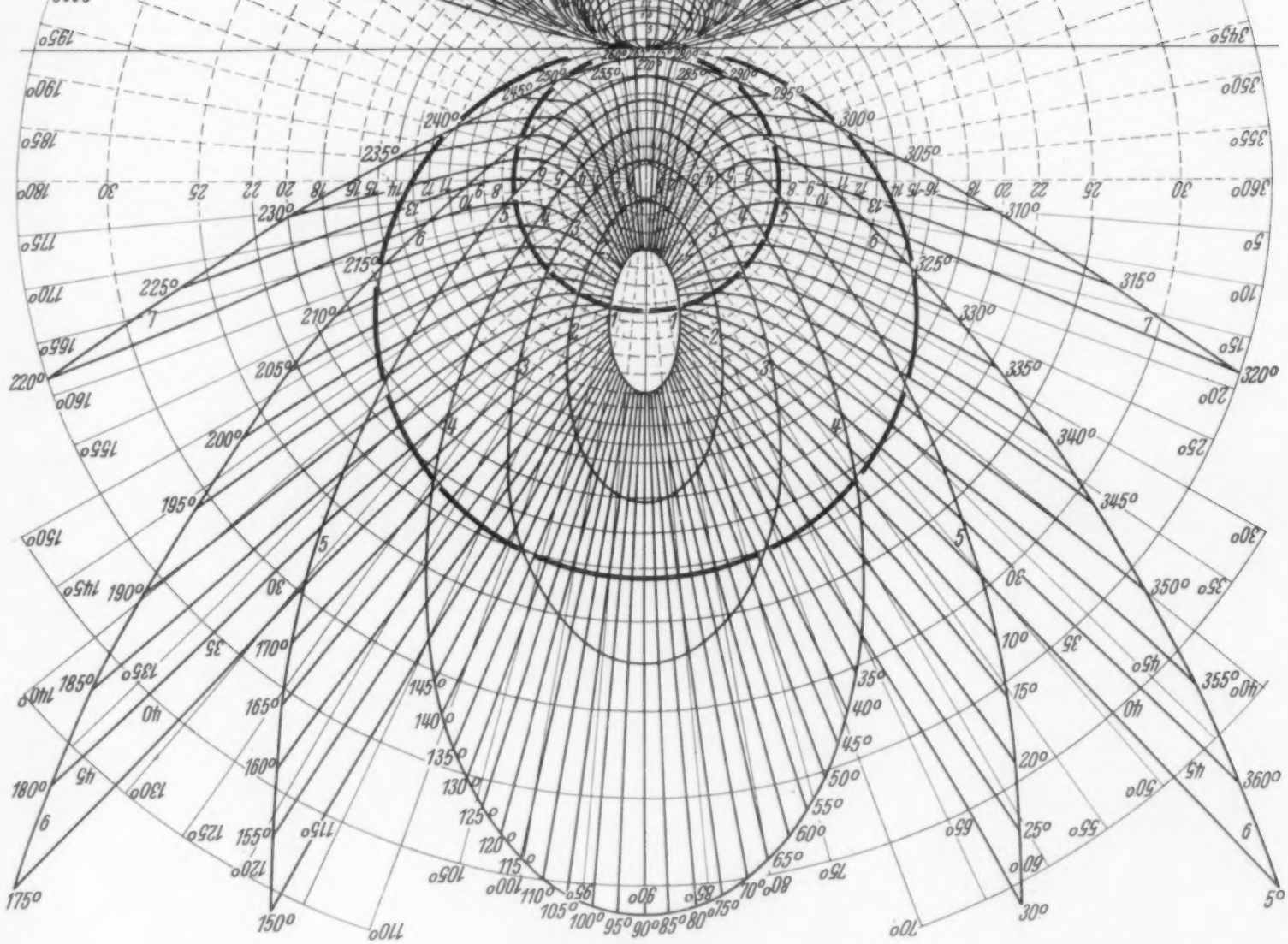
The diagram shows the elliptical paths of two arbitrary points, E_1 and E_2. Portions of these elliptical paths have been replaced by circular arcs, and the centers of curvature, K_1 and K_2, found. Note that these centers are on an extension of the lines PE_1 and PE_2, where P is the common pole of the two circles.

If E_1K_1 and E_2K_2 are taken as two links in a 4-bar linkage with K_1 and K_2 as stationary points, points E_1 and E_2 will be the coupler points describing circular arcs which, within a certain range, approximate the elliptical paths.

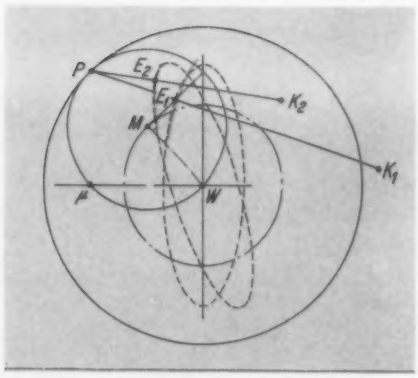
If these coupler points are connected to W on the circumference of the Cardan circle, this point will describe the desired straight line as long as points E_1 and E_2 move on those parts of the circular arcs that

1 . . PROPORTIONS OF 4-BAR LINKAGES are determined with this special chart—made up of two separate systems. One finds coupler points; other finds stationary points. For coupler points, read figures from circles and rays. For stationary points, read figures from ovals and curved rays.

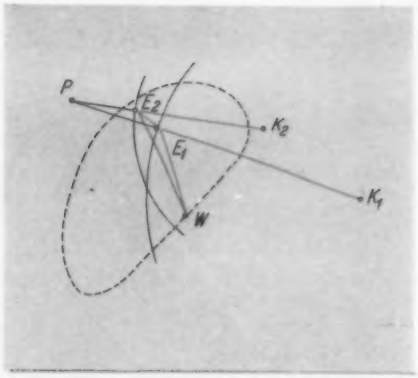
For coupler points, turn this way



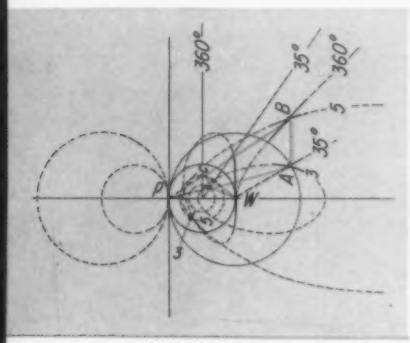
For stationary points, turn this way



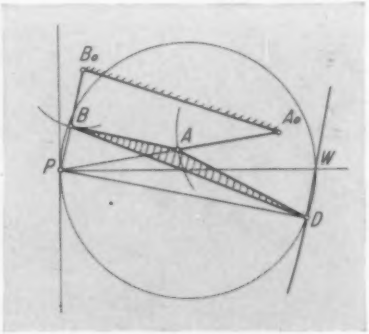
2 . . PATHS OF TYPICAL POINTS during rotation of Cardan circle. Here, circular arcs have been drawn replacing parts of the elliptical paths of E_1 and E_2. K_1 and K_2 are centers of curvature of these arcs.

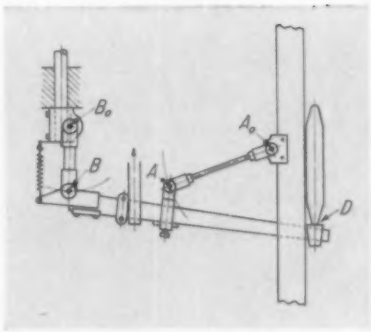


3 . . ACTUAL LINKAGE determined in Fig 2 causes point W to describe the desired straight-line path during part of its complete path which is shown by dotted line.



4 . . POINTS FOUND from special chart produce desired straight-line motion. Points A and B are arbitrary; points D and C determined from chart.





5 & 6 . . WEAVING MECHANISM (right) is designed to fit points (left) determined by the chart. A_o and B_o are chosen to give required length of travel for point D; A and B are found from chart. Note that D travels at slight angle from vertical.

closely approximate the elliptical paths they replace. The complete path described by coupler point W is shown dotted in Fig 3 together with the 4-bar linkage that produces it. This linkage results from the arbitrary selection of points E_1 and E_2 and the development of centers K_1 and K_2 from the chart.

How the Chart Works

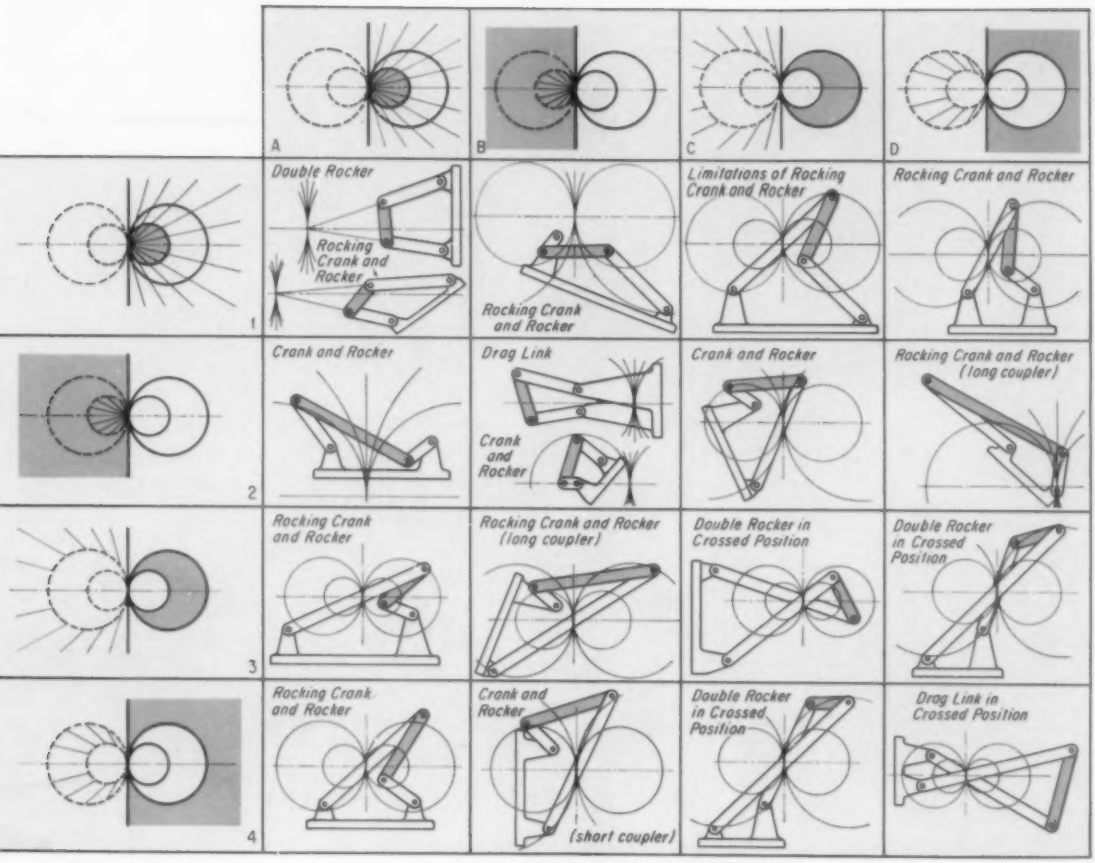
The chart has been constructed so that you can find the coupler points corresponding to two given stationary points (centers of curvature) or vice versa. Here is how:

Concentric with the Cardan circle is a system of circles that are divided by rays at 5° intervals. The intersections represent possible coupler points. A companion system of ovals, divided by curved rays at 5° intervals, represents the possible fixed points (centers of curvature). To use the chart, start with whichever pair of points, coupler or fixed, are predetermined. Then locate these points in the appropriate system; the corresponding points will be located at the same-numbered intersections in the other system. When the coupler points thus determined are connected to a point on the Cardan circle, this point will produce straight-line motion through point W.

Solving a Sample Problem

In Fig 4, straight-line motion is desired at point W. Stationary points A and B are selected as shown. A falls on the intersections of oval 3 and curved ray 35°; thus corresponding coupler point D is at the intersection of circle 3 and ray 35°. Similarly, B falls at intersection of oval 5 and curved ray 360°; its coupler point, C, at intersection of circle 5 and ray 360°.

Coupler points D and C are connected to W on the circumference of the Cardan circle, which will then describe the desired straight line as shown. The best approximation of a straight line is obtained when the coupler points are connected to W or points near it. The straight-line portion of the path described by W is in a vertical direction. When C and D are connected to other points on the Cardan circle, the straight-line portion will go through W at an angle to the vertical, depending upon distance of the chosen point



7 . . A VARIETY OF MECHANISMS can be produced by choosing points from different parts of the chart. In each case, colored coupler is produced when one point is taken from colored area in first column and other from colored area in top row.

from W. Thus any desired direction of travel is possible in theory. However, there is this limitation: the further the chosen point is from W, the less accurate the approximation of straight-line motion.

This effect is more clearly shown in Fig 5, which gives another 4-bar linkage proportioned from the chart. In this case points A_o and B_o are centers of curvature for coupler points A and B, which are connected to tracer point D. A_o and B_o are predetermined points on the machine; A and B are found from the chart.

The straight-line portion of the coupler path described by point D goes through W at an angle as shown. A typical application of this 4-bar linkage is the weaving mechanism (Fig 6), used in the textile industry. Proportions for this mechanism are determined from the sample 4-bar linkage determined in Fig 5.

Wide Variety Possible

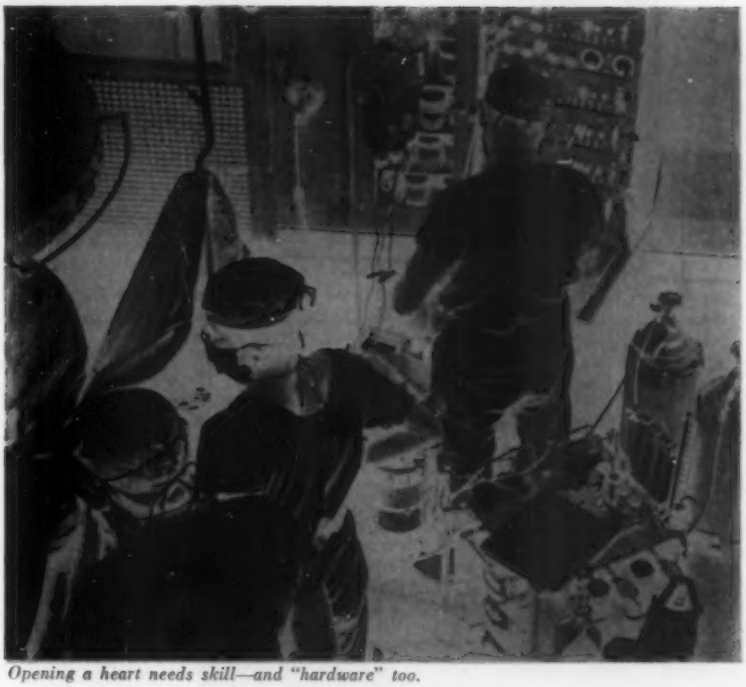
Coupler points for a 4-bar linkage can fall anywhere on the chart, depending upon the type of mechanism required. Fig 7 shows diagrammatically the wide variety of mechanisms that may be determined from the chart. The relation of the coupler points to their corresponding centers of rotation to the Cardan circle determines the type of mechanism. For example, if both coupler points fall within the Cardan circle on the right-hand side of the chart, the type of mechanism will be 1A. On the other hand, if both coupler points fall on the left-hand side of the chart, the type of mechanism will be 2B. However, any combination of these is possible, as can be seen from the diagrams.

EDITOR'S NOTE: For additional information on design of 4-bar linkages see:

Robert's Law Helps You Find Alternate 4-bar Linkages, Oct 27 '58, p 54—Method of similar triangles is explained and expanded by author's method of laying off the link lengths along a straight line.

Linkage Design Techniques, Dec '54, p 133—Gives comparison of 4 methods—two approximate and two exact—for construction and design of 4-bar linkages.

Linkage Layouts by Mathematical Analysis, Aug '55, p 165—Shows how to obtain a specified relationship between input and output for a differential by determining number and types of links needed.



Opening a heart needs skill—and "hardware" too.

medicine consults the design engineer

The medical profession has made big strides with assists from chemistry, biology and the natural sciences. Now, doctors say, help is needed from engineers. Here's a look at latest equipment.

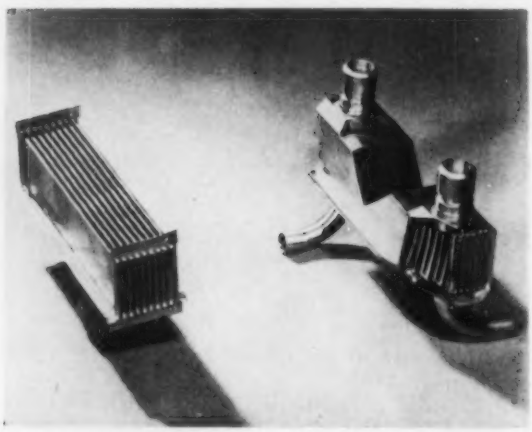
DORA K MERRIS
Assistant editor

Medicine, it has been said, always borrows from the dominating intellectual movement of an era. During the renaissance of art, the profession made strides mapping the body and its parts. Then, in the 19th century, it drew heavily on chemistry. In our current R & D era, medicine is turning to engineering.

Even so recently as the end of World War 2, medicine remained almost untouched by engineering. That situation has changed noticeably; now many companies are designing medical equipment. Here are indicators: This year, Garrett Corp offered a heat exchanger to cool kidneys during operations. Hughes Aircraft announced a solid ionization chamber—a slice of "doped silicon"—that emits a pulse when struck by a nuclear particle; it's said to be potentially useful in controlling radiation therapy in cancer treatment. Minneapolis-Honeywell announced formation of a medical-electronics group. RCA, Airborne Instruments Lab, a division of Cutler-Hammer Inc, and many others have medical equipment under development. In the materials field, Dow Corning has a year-old

Copyright 1960 by McGraw-Hill Publishing Co Inc, 330 W 42nd St, New York 36

DESIGNED FOR HEART SURGERY, this crescent-shape blade combines delicacy with speed. It fits under the surgeon's fingernail, is held in place by finger-encircling metal band. Developed by Austin R. Baer, North Carolina State College, the blade combines two functions. (1) With it, the surgeon first explores the trouble spot. Sensitivity of the under-nail area gives him a good "picture" of heart damage (he's wholly dependent on sense of feel and knowledge of heart construction). (2) Then, if situation warrants, he can perform surgery immediately with same blade—traditionally, he has had to reenter with other instruments. Blade is investment-cast from a mold of the surgeon's finger—no two human fingers are alike. Instrument has already been used at Bailey Thoracic Clinic, Philadelphia.



HEAT EXCHANGER gives blood a needed cooling during open-heart surgery. Blood and cooling water are kept separate by stainless steel walls 0.005 in. thick (left). (Right): cutaway view of the unit, designed by Surgical Instruments Co, Baltimore.

Center for Aid to Medical Research, which provides technical assistance for doctors on use of silicones in medicine and surgery.

But doctors still feel that not nearly enough development work is underway. They see vast untapped promise in computer, missile and nuclear technology, in new materials, miniaturized electronics, and even in the new mathematics. But instruments developed by industry are generally an extension of a company's technology. The company develops them only when it sees a sizable market, and the medical market will probably always require more variety than volume.

DOCTORS THINK UNLIKE ENGINEERS

But the most serious barrier to medical engineering, many doctors say, is not the small market but the inability of doctors and engineers to work well together. Companies frequently urge their engineers to visit, observe and talk with doctors when working on projects. But the difference in educational background makes understanding difficult (*PE*—May 30, p 20).

As one medical researcher puts it: Medical practice is based on prodigious memory coupled with shrewd intuition; it is highly empirical. The engineering profession, on the other hand, is rooted in science; the engineer is primarily concerned with the logic of a given problem. Time and again, when doctors ask engineers to design equipment, the result is unsatisfactory from a medical standpoint. The engineer then becomes angry because the doctor has not given him adequate specifications.

One frequently hears engineers decry the lack of basic design data: "How the devil can we design refrigeration equipment for transporting blood when doctors can't agree on the temperature at which blood is damaged?" asks one engineer. Another, attempting to evaluate heart-lung bypass equipment, concludes that of the available systems, none seem especially good from an engineering standpoint. "But then," he says, "it's awfully hard to know what doctors really want."

Dr Kenneth Burdick, a dermatologist at Cleveland Clinic, finds the engineering approach fascinating, but not wholly adequate. "Engineers," he says, "have difficulty appreciating the vast number of variables in even the simplest biological problem. But it is enlightening for medical researchers to watch engineers attempt to reduce biology and physiology to formula. This approach is vastly different from the medical method of inducing principles from changes that have taken place."

VOLUNTEERS NEEDED

Medical engineering is progressing outside of, as well as in, industry. Shortly after World War I, Mayo Clinic set up an engineering section. The group now consists of four electrical and three mechanical engineers. Few hospitals have followed Mayo's lead, to the dismay of some physicians; but hospitals just don't have the money. Doctors generally rely on consultants—especially appreciated are those who will donate time without charge. The Michigan Cardiovascular Research Assn reports considerable success in getting members of the Detroit Div of the American Society of Tool Engineers to work at home.

The armed services have set up a medical-equipment development center at Fort Totten, NY, for translating military needs into hardware. And the Veterans Administration has helped disabled veterans, thanks to close cooperation between engineers, on the one hand, and medical and social scientists on the other.

A number of research groups, such as Franklin Institute and Battelle Memorial Institute, take on medical assignments. And at least one medical-engineering consulting firm is getting underway. Founded by Dr Selwin McCabe, the group proposes to assemble a team of doctors and technologists to work on these problems.

By now, engineering has touched—though lightly—many medical practices. The impact is especially felt in heart-lung bypass equipment, various measuring devies, and equipment for operating rooms and hospitals. Specialists in human engineering are working with doctors in contributing to prosthetics, mechanical aids for the handicapped, and gear for space travelers.

AID FOR VETERANS

Engineers have done outstanding work in contributing engineering logic to the problems of designing artificial limbs for amputees, according to Anthony Staros of the Veterans Administration Prosthetics Center in New York. The engineer, he says, became involved after World War 2, when Congress voted $1 million a year to rehabilitate disabled veterans. Relatively little bio-mechanical data was available then. Now, a variety of complex hydraulic systems to simulate certain phases of human movements is under evaluation by the VA. The work has been done at Northwestern, the Univ of Calif and elsewhere.

Some notion of the mechanical and other problems these researchers face is indicated by the design of a hydraulically operated knee that will become available for evaluation later this year. Developed by Hans Mauch of Mauch Labs Inc, Dayton, Ohio, for the Prosthetics and Sensory Aids Service of the VA, the knee simulates the swing of the human leg, but eliminates some of the more complex muscular functions involved in walking up and down stairs. The simplification is necessary, Mauch says, because communication channels between man and his prosthesis are inadequate to control a more complex assembly. The human joint, he explains, is essentially a bearing with muscles. They lengthen to absorb mechanical energy and act as a damping device; they shorten to perform mechanical work, support static loads and act as a lock. These functions can be duplicated by bearings, artificial bones, actuators, damping devices and locks. But the natural nerve system to control them cannot be duplicated. Considerable work is underway to use existing nerves or find better techniques for controlling artificial limbs.

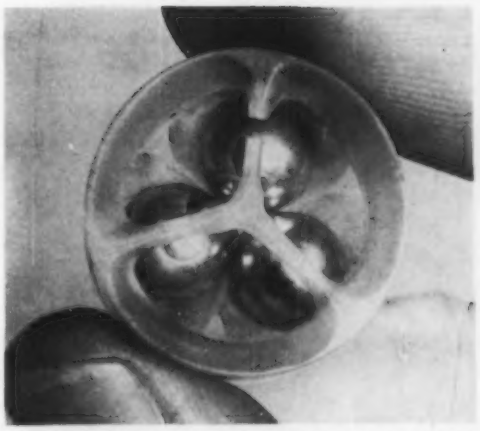
Other design problems include selecting materials with high strength-to-weight ratio. And VA is working on porous plastics for limbs; reduced body area reduces perspiration and causes a heat-transfer problem, hence the need for materials allowing better ventilation. VA also seeks materials for socket area where prosthesis contacts the body. A Dacron fiber blanket by Troy Blanket Mills is now under study.

SUBSTITUTE HEARTS AID SURGEONS

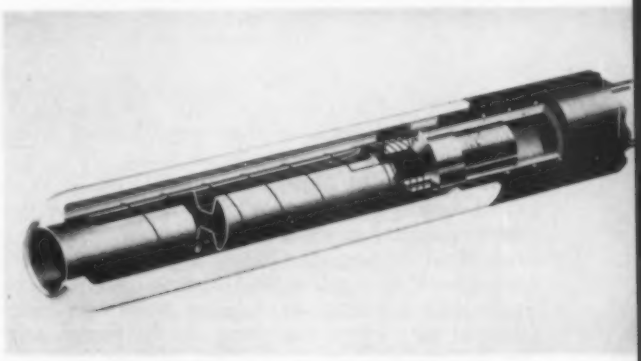
The heart, although a dramatically reliable organ, sometimes requires surgical repairs. A great boom to such surgery is the heart-lung bypass equipment that temporarily takes over heart functions. Here, a mechanical pumping system maintains blood flow to the body, an oxygenator exchanges carbon dioxide for air, and various control devices ensure that blood flow, temperature, carbon dioxide content and other physical-chemical conditions match the doctor's prescription.

The original equipment was conceived by doctors; some of it has been redesigned by engineers. One of the most promising development projects is said to be the heart-lung machine suggested by Dr John Gibbon of Jefferson Hospital, Philadelphia, then developed by IBM, and later modified at Mayo Clinic. In the oxygenator for the IBM machine, blood flows down vertical screens of stainless steel mesh, thereby exchanging its carbon dioxide for oxygen. The pumps, based on a concept proposed by Michael DeBakey of Baylor Univ, consist of two sets of rollers at either end of a rotating arm. These rollers partially close flexible tubing to push blood on its way. Blood is too fragile for standard commercial pumps.

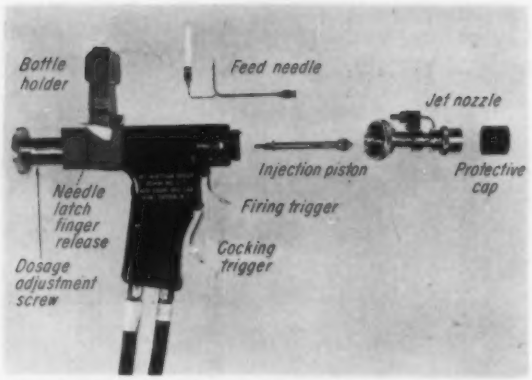
The most challenging problem, according to IBM engineers, was designing the oxygenator. They had to find the best combination of height, width and number of screens to assure maximum efficiency of gas exchange. In



EXPERIMENTAL HEART VALVE, built on ball-check-valve principle, allows blood to flow in freely, until chamber is full; fluid pressure then closes valve. This configuration is especially resistant to wear because the free ball presents a new surface each time it seats. Three-ball setup shortens axial dimension of valve and provides safety of parallel units. This is one of many configurations under investigation at Ohio State Univ.



PRESSURE TRANSDUCER for exploring inside of heart chambers reaches its objective by way of vein. It is only 0.090 in. long, with 0.040-in. effective inside dia. When attached to a No. 6 French catheter—a device that collects blood samples—unit can be safely threaded through heart compartments to detect damage. Entire assembly is 0.65 in. long, was developed for Henry Ford Hospital.



SHOTS WITHOUT NEEDLES: jet injector, developed at Fort Totten, NY, shoots immunization fluids with enough force to penetrate skin—no need for the usual hypodermic needle. Unit has two main assemblies—the vaccine pump and hydraulic system that operates it. Immunizer is drawn through feed needle into the pump, then ejected through the jet nozzle. The electrically operated hydraulic system compresses a large spring (not shown), which is attached to the injection piston. When hydraulic fluid is released into a hydraulic reservoir, the sudden pressure drop drives the spring forward. The hoses carry the hydraulic fluid. In tests the device has been clocked at more than "painless" 1400 shots an hour.

the final model, mesh openings were designed to cause gentle turbulence of passing blood.

There are other oxygenator concepts. Dr C. Walton Lellehei of Univ of Minnesota Medical School has developed equipment in which gas exchange occurs as oxygen and blood bubbles up through a long tube. Another example—V. O. Bjork of Stockholm, Sweden, has worked on a disk oxygenator which passes blood over rotating disks in an oxygen atmosphere. As for pumps, several small American firms here report they are working on models that more nearly simulate the normal action of the heart, but details have not yet been released.

Now that surgeons have access to the heart, defective parts can be replaced with prosthetic devices, such as artificial valves.

A replacement valve must open and close under normal blood flow, have smooth walls to avoid damaging the blood and be made of a material with high strength-to-weight ratio. The material must also have high corrosion resistance and prevent collection of deposits of fibrin (a blood-clotting substance). The natural valve is an extremely light, flexible leaflet that offers practically no resistance to blood flow when it is open, then closes rapidly when blood flow tends to reverse. Over a lifetime this cycle is repeated 2 to 3 billion times.

One project, by W. L. Starkey, prof of Mechanical Engineering at Ohio State, has resulted in a device based on the principle of the ball-check valve (photo, p 83). Prof Starkey worked with a heart surgeon, Dr Howard D. Sirak, when developing the valves now under evaluation.

Another, under development at Cleveland Clinic, consists of flexible leaf-shape flaps whose outer edges touch and whose bases form a solid circle in each valve. The clinic reports that choice of material is the most difficult problem—it must be flexible, and strong enough to withstand continuous movement in a cross-section as thin as 0.005 to 0.007 in. The clinic is now leaning toward polyurethane.

REPLACEMENT ORGANS NEXT?

Artificial valves are viewed as a waystation to an entirely artificial organ. Though there are sharp differences of opinion in the medical profession, some doctors believe that artificial organs can be developed much more rapidly than the science and technique of transplanting organs. Work is progressing today primarily on the heart, lung, kidney; also on the liver, uterus and others.

A leading research group here is the Dept of Artificial Organs at Cleveland Clinic, headed by Dr Willem Kolff. Its ultimate objective is an artificial heart. Admittedly this is a far way off; at present the clinic is considering such engineering problems as size, weight, motor power and materials. The researchers have decided that electricity should be the best power supply. They have enlisted Globe Industries and Thompson Ramo Wooldridge to work on this problem. The first effort by Globe was a dc motor. It was compact, but rotor brushes wore out too quickly. Globe then turned to an ac motor for which engineers designed special bearings, wiring and magnets. This version is about 1¼ in. dia, 3 in. long and weighs about 300 grams. Guaranteed life for the device was extended from about 50 days to a year—a substantial improvement, but obviously insufficient for human needs. Housings for the motor pose problems that are being tackled by Curtiss Industries of Cleveland.

TRW is also working on a magnet-powered heart motor. This unit has the advantage of fewer moving parts and greater durability. But for a given power output, this type is larger and heavier than its competitors. It also generates heat. TRW is looking for more efficient magnetic materials.

NEW GAGES COMING

New instruments coming out of development labs today include tiny probes to measure physical changes in remote parts of the body; devices for monitoring physical changes over long periods; devices for measuring intensity of flow or radiation and for correlating data.

One such device is a 0.65-in.-long pressure transducer that can be inserted in a vein leading into the right heart valve. Once in the heart, the transducer senses changes that indicate a leak between heart valves—apparently a fairly common cardiac condition. Developed by Ford Scientific Lab in cooperation with Henry Ford Hospital, the device is now being tested and is expected to become available to hospitals soon. The transducer is attached to a catheter (a device for sampling fluid inside the body) so that samples of blood can be taken as well. In developing the instrument, Ford engineers tried a number of shapes and finally settled on a hollow cylindrical shape wound with 0.0005-in.-dia wire (photo, p 83). An important part of the system is a dc amplifier that raises the transducer's output—4 microvolt for a pressure of 1 mm of mercury—to a level suitable for analysis by standard hospital equipment.

At Cleveland Clinic, prolonged monitoring of electro-

cardiographs is now possible with a tape-recording technique developed by Joseph F. Dobosy, an engineer with the consulting firm, Essential Electronics Inc. Normally, electrocardiograms are recorded on photosensitive paper or writing paper. At the request of Dr William F. Proudfit of the clinic, Dobosy looked over a few such cardiagrams, checked AMA specifications for the frequency response required and concluded that any device that would take a square wave would do the job. The device that resulted will record for 8 hr with a 2-in.-dia tape moving at 1⅞ in./sec. If nothing medically significant occurs during that period, tape is reused.

Illustrating the difficulties of finding the man to do the job in the highly disorganized field of medical engineering, Dr Proudfit relates that he met Debosy quite accidentally. He discussed the problem of tape-recording EKG's with his neighbor, chief engineer for a local radio station, who in turn contacted Dobosy and persuaded him to see Dr Proudfit. Dobosy spent many hours, without compensation, developing this equipment—a dedication that Proudfit says is characteristic of many engineers working on medical problems.

But doctors don't always get their man. Dr Burdick of Cleveland Clinic reports that dermatologists have devised treatment for sunlight sensitivity that far exceeds ability to determine precisely what part of the light spectrum a patient is sensitive to, and at what intensity. Current practice is to expose a patient to sunlight or mercury light reflected through ordinary window glass. This glass transmits all radiation larger than 3200 Angstroms—though they may vary from 3000 to 3400. Hence, measurement is rough and gives the dermatologist only a very crude guide to the treatment he should prescribe. Dr Burdick has taken the problem to a very large company employing hundreds of engineers in light sensitivity. So far he has not located the particular engineer to solve his problem.

GAGE MAY REDUCE BIRTH INJURIES

A strain gage, developed by Battelle Memorial Institute for physicians at Holzer Clinic, may eventually lead to better designed forceps for obstetrics. Doctors suspect that many cases of cerebral palsy, mental deficiency and similar afflictions may originate from the harmful pressure of instruments at birth. Battelle has accordingly equipped standard forceps with strain gages that transmit pressure changes electrically to a recording instrument. This assembly is expected to provide exact and detailed information heretofore unavailable.

At Philadelphia's Franklin Institute, a group of engineers under direction of C. W. Hargens is attempting to determine frequency and impedance of human eye vibrations and their relation to pressures within the human eye. Excessive pressure leads to glaucoma, which often causes blindness. To determine interocular pressures, doctors now anesthetize the eye and measure pressures with a tonometer. With data on dynamic behavior of the eye and its relationship to pressures, Franklin engineers hope to design instruments that can measure interocular pressures more quickly and safely than is now possible.

EQUIPMENT BEING SIMPLIFIED

Standard equipment for hospitals and doctors' offices is produced generally by small, highly specialized firms that turn out a traditional product with a tradition of quality. Much of this equipment, some engineers contend, is unnecessarily complex and heavy.

FOR SAFER CHILDBIRTH: these forceps with pair of strain gages were developed at Battelle Memorial Institute to give obstetricians research data heretofore unobtainable. The gages measure both compressive and traction forces. A physician fixes the forceps around an infant's head by adjusting the screw on the handle. Any changes in pressure are measured by a strain gage on shank of upper blade and recorded on a continuous chart. Traction forces—also continuously recorded—are measured by a strain gage on the long bar.

Progress in designing easy-to-maintain, rugged but lightweight equipment has been achieved for the military by a design group at Fort Totten, NY. Under auspices of the Armed Services Medical Material Coordinating Committee and the immediate direction of Col Raymond J. Karpen, this group of four mechanical, two electrical, and two chemical engineers design equipment for service doctors in the field.

The emphasis on simplicity has resulted in a diagnostic audiometer that tests hearing in the field. Simpler than commercial units, this audiometer has only two electron tubes and can be calibrated by a technician just by turning a few screws. The calibration equipment is housed in one compact package. Standard commercial equipment, Totten engineers point out, normally comes in two units —an oscilloscope to calibrate frequency and a generator to calibrate sound threshold. Adjustments are costly.

The Totten engineers have also designed an aluminum sterilizer that cuts weight for such equipment from 475 to 125 lb. The unit includes ends that fold up for carrying, and down for raising sterilizer to working level. Before this project was undertaken, industrial consultants warned that an aluminum sterilizer was impossible.

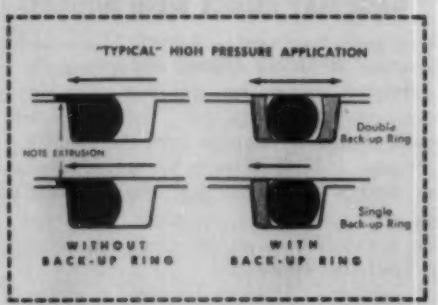
Totten engineers have also found a simple way to eliminate the weight and expense of buckles for litters. The answer: Velcroe. This bristly plastic material adheres firmly to itself under shearing loads, yet is easily separated, when necessary, by peeling the layers apart. ■

NOW – Increase O-Ring Life and Reduce Costs with...

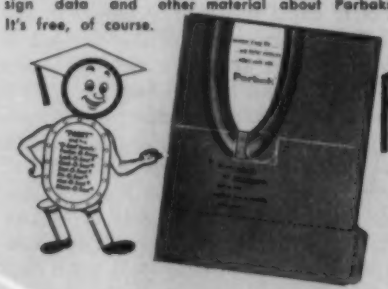
Parbak*

The only contoured and continuous back-up ring... simplified, easy-to-assemble, resists higher pressures!

Here's the first really new back-up ring in years . . . Test after test, both in the field and laboratory, has proved that Parbaks* greatly increase O-ring life. In addition Parbaks* improve lubrication, are easy to assemble, and resist higher pressures — *yet they actually cost less* than back-up rings for similar useage!



Why not get the facts about these unique rings, now. Send for catalog 5482 — 8 pages of design data and other material about Parbaks.* It's free, of course.



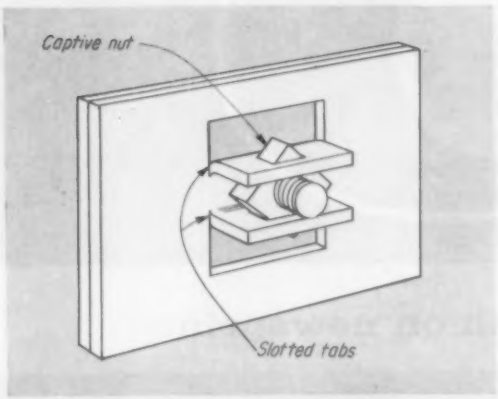
Parker SEAL COMPANY
Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

* Trade Mark

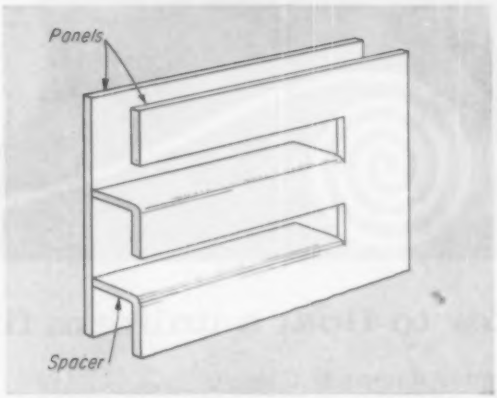
10 more ways to save money with LANCED SHEETMETAL PARTS

First half of this series of design suggestions appeared in the Sep 5 issue.

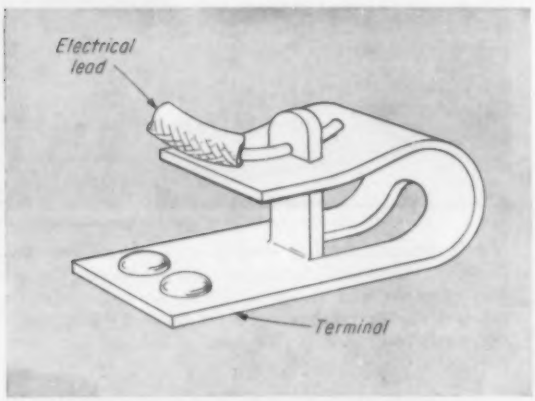
FEDERICO STRASSER
Mankowitz & Strasser
Santiago, Chile



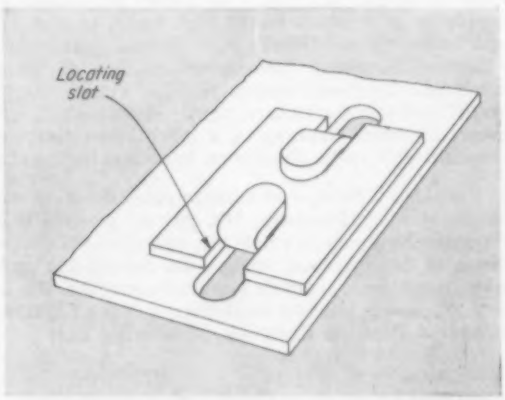
1 CAPTIVE NUT allows blind assembly on panel too thin to tap. Nut is held firmly, cannot get lost.



2 SPACERS separate panels with fewer parts and with less weight than extra strips or filler materials.

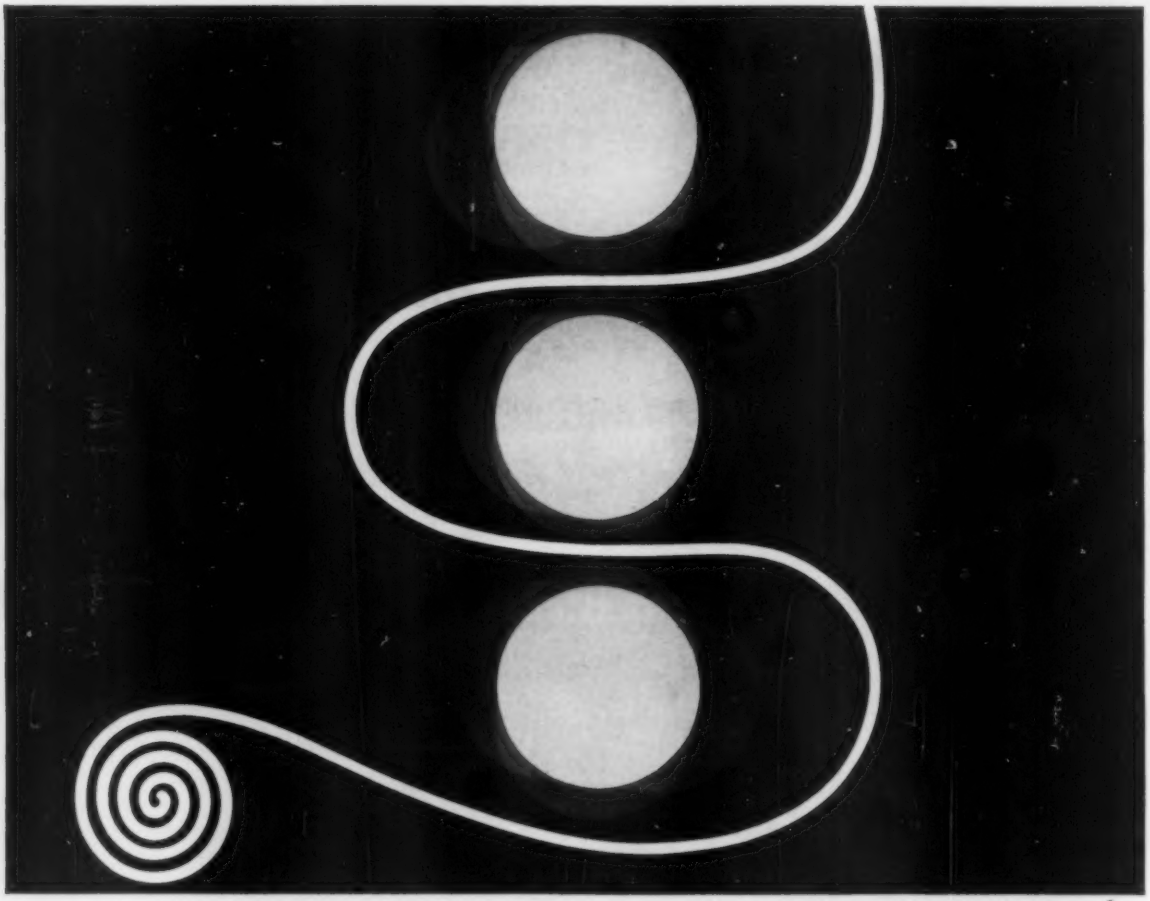


3 TERMINAL made of flat spring stock presses wire lead tightly in lanced tab, yet releases easily.



4 TABS fit into slot to align in one direction as well as fasten. Matching tab and slot on other side would align plate in second direction.

continued, page 89



How to float a uniform finish on newsprint

Firestone Airmount® Controls Roll Pressure in New Papermaking Machine

Far advanced over the old, manual method of controlling roller pressure, or "nip," in paper production—when inequities in pressure meant high spots, uneven finishes and other flaws—Beloit Iron Works today is using Firestone Airmount controls on its line of newsprint machines. Airmount assures positive quality control of "nips" and rolls (see picture, right); cuts costs by providing longer life than diaphragms, a much lower first cost for the entire unit, and a much lower labor cost for installation.

In the paper industry—as in many other fields—Airmount ideas pay off handsomely. It's entirely possible that the Firestone Airmount principle—in widespread use in trucks, buses, automobiles and trains—can benefit *you* on actuation, suspension, shock or vibration problems. For a low-cost, long-range solution, write Department 41-5, Firestone Industrial Products Company, Noblesville, Ind.

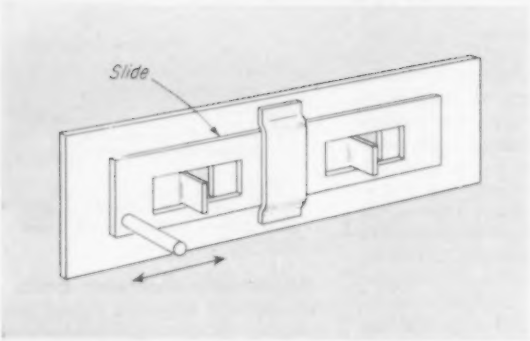
(Newsprint Machine Patent and Patent Pending—Beloit Iron Works)

Here's positive quality control of papermaking through Firestone Airmount! As air goes into the bellows, the scissors arrangements tend to open, lifting the roll and relieving pressure on the paper as it's fed between rolls. "Nip" is rigorously controlled at all times.

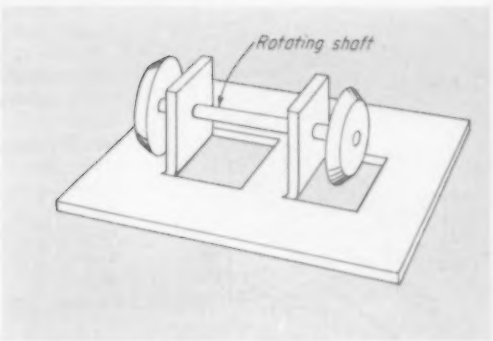
Firestone

AIRMOUNT® FOR INDUSTRY

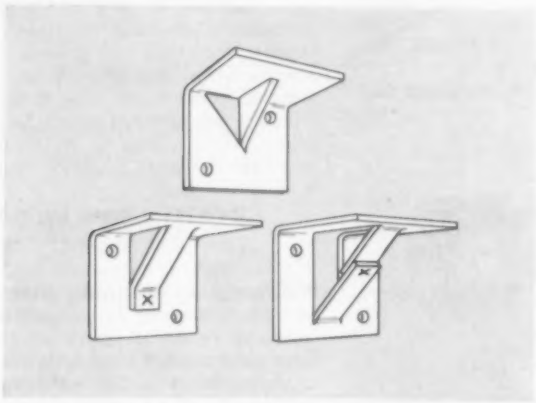
Firestone Industrial Products Co., Noblesville, Indiana



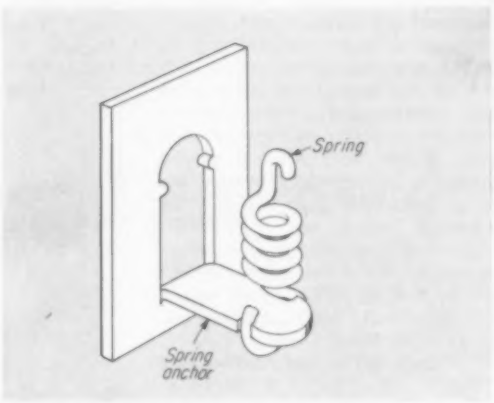
5 SLIDE rides on projecting tabs. At same time, tabs act as limit stops. Length of slot determines how far the slide can travel.



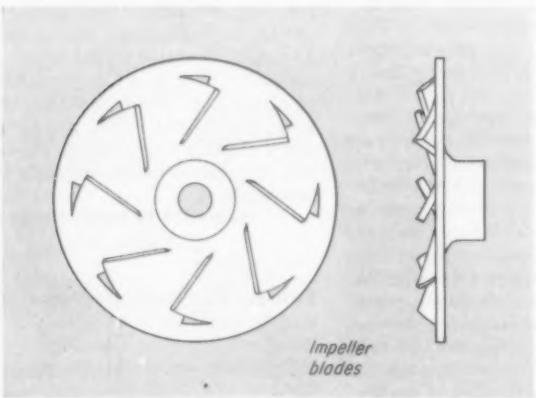
6 RAISED TABS are bearings and supports for rotating shaft in light-duty applications. Tabs will also guide sliding rod or bar. Bent-up end of plate can take place of a tab.



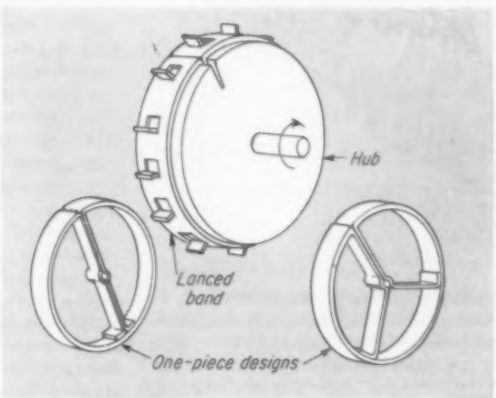
7 REINFORCEMENT RIBS of three different designs all give support for wall bracket, yet retain one-piece construction.



8 SPRING ANCHOR—possible variations: tab with hole, or tab with only one notch for spring that pulls to side.

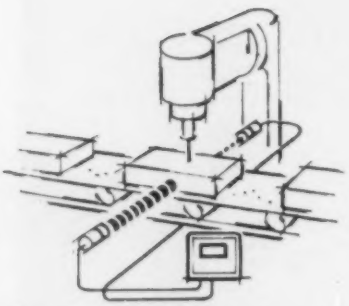


9 LANCED BLADING results in one-piece construction of lightweight cooling fan for small motors.



10 CONTINUOUS STRIP is lanced while flat, then cut to length and rolled into a sprocket. Small sketches suggest ways to avoid a separate hub.

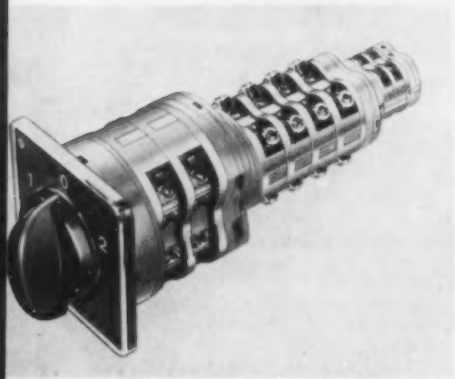
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Ultrasonic sensing and switching system . . .

uses beams of ultrasonic sound waves to count, control or monitor. Basic system, two sensors and a control unit, operates somewhat similar to a photoelectric device, utilizing sound waves rather than light for its beam. Every time sound beam is interrupted, control operates. Said to be unaffected by vibration, dust, smoke or light level. Control unit or amplifier is fully transistor-equipped and has no replaceable parts. Sensors are hermetically sealed and suitable for weatherproof or explosionproof operation. Control unit need not be installed in same basic location as sensors. Basic unit is $119. From stock. **Aro Equipment Corp, Industrial Div, Bryan, Ohio.**

Circle 300 on Reader Service Card



Modular rotary switches . . .

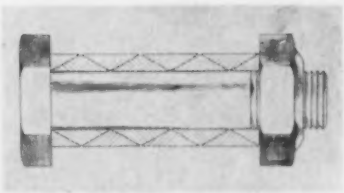
permit switches with any practical contact arrangement to be assembled in a few minutes from modules in stock. Units are built around stage that contains up to four isolated, double-break, silver-alloy contacts. Up to 12 stages can be contained in column and up to three columns, arranged in tandem, can be used in switch assembly. Hence, as many as 96 double-break contacts over 36 positions can be controlled from a single point. Each column of stages is equipped with a latching mechanism, cams and a stop, the assembly constituting a basic switch. Mounting units are added by twist-to-lock bayonet principle, which also permits addition of accessories and enclosures. Standard ratings can be supplied at 20, 32, 40, 63, 100 and 200 amp, 600 v ac. Manually operated switches are said to be 30% lower in price than comparable competitive switches. Delivery on most standard units about 2 wk. All units are hp-rated for use in motor control, instrumentation and control-circuit applications. **American Solenoid Co Inc, US Highway 22, Corner of Madison Ave, Union, NJ.**

Circle 301 on Reader Service Card

Self-locking capscrew . . .

has configuration of conventional hex head capscrew with double cap, a concave head; and a seating-type, all-metal, reusable locking collar. Particularly for use where vibration, high tensile strength, corrosion and high temperatures are factors. When stud is pulled down and proper torque applied, collar compresses, causing inside of collar to move in and lock radially and axially on stud shank and cap shoulder. When cap picks up all the load it can carry, concave configuration of cap permits it to adjust to torsional load equalizing stresses and applying constant pressure through elasticity in cap design. Elasticity is said to be more than three times that of conventional capscrew. Available in various metals and materials to meet specifications and operating environments, in all standard sizes (6-32 and up) and threads. Current head style available is standard hex head. **Klincher Kapscrew Inc, Dept SLK-227, 2153 Hillside Ave, Indianapolis 18.**

Circle 302 on Reader Service Card



Adjustable-diameter bolts . . .

achieve tight cylindrical fits and precision clearance fits, as well as compensating for wear, by mechanical adjustment of diameter. Consist of standard bolts, self-locking nuts and adjustable-wall-thickness bushings. Tightening of nut adjusts bolt diameter. Said to eliminate close-tolerance machining or reaming of holes. Adjustable-wall-thickness bushings also facilitate installation and removal. Available in various materials, nominal bolt diameters (standard sizes from $\frac{5}{16}$ through $\frac{3}{4}$ in. dia) and lengths as desired. Delivery ranges from 1-2 days to 2-3 wk max. **Adjustable Bushing Co, 12036 Vose St, N Hollywood, Calif.**

Circle 303 on Reader Service Card

Bidirectional stepping motor

operates on magnetic reversals, achieving speeds up to 400 steps per sec. Each input pulse or current-reversal causes 18° of shaft rotation within $\pm\frac{1}{4}°$. Typical applications are as a positioning servomotor (digital positioner), digital-to-analog converter or high-torque, instant-start synchronous motor. Unit offers 20 positions, 10 for each alternate + and − input; magnetic detent; one moving part rotating in ballbearings; max torque of 1.15 in.-oz; inertia of 0.0066 in.-oz^2; driving power of $\frac{1}{4}$ to 40 w depending on speed and load; life of 50 million revolutions. Approximate over-all size, excluding shafts, is $2\frac{5}{32}$ x $1\frac{31}{32}$ x $2\frac{13}{32}$ in. **Sigma Instruments Inc, 195 Pearl St, South Braintree 85, Mass.**

Circle 304 on Reader Service Card

Self-conforming polymer seal

is spring-loaded for applications in reciprocating and low-speed rotary shafts under high-pressure liquid and gas conditions. Operates over temperature range of −320 to 500 F and under pressures up to 10,000 psi. Seated around shaft, seal sets up load toward shaft, its polymer gasket deforming

under constant pressure to produce gas-tight seal. Deformation is always toward shaft and self-adjusting to creep and wear. **Del Mfg, Div of Arrowhead-Puritas Waters Inc, 1005 S Central Ave, Los Angeles 21.**

Circle 305 on Reader Service Card

Six industrial valves . . .

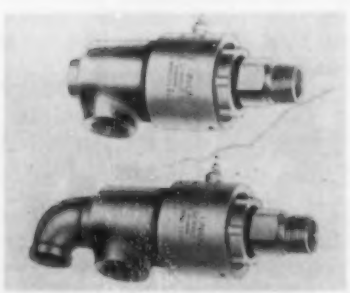
for use primarily as control, regulating and relief valves in hydraulic systems with operating presures up to 3000 psi are said to be extremely sensitive and responsive to changes in pressures. Built for severe service. **Besler Corp, 4053 Harlan St, Emeryville, Oakland 8, Calif.**

Circle 306 on Reader Service Card

Electromagnetic clutch-hub . . .

is clutch package incorporating bearing-supported adapter hub to facilitate mounting of desired sheaves, pulleys or sprockets. Assembly can be used as driving or driven member. (Illustrated with sprocket and chain drive on through-shaft application.) Open models can be obtained for either stub or through mounting, while optional shrouded models, providing integrally mounted brush-holder boxes and protective guard for rotating clutch parts, are supplied for stub-shaft installations only. Available in ½ to 20 hp ratings in standard bore sizes of ⅜ to 1⅜ in. dia. **Cycledynamics Inc, 19025 W Davison Ave, Detroit.**

Circle 307 on Reader Service Card



Automatic-seal rotary union . . .

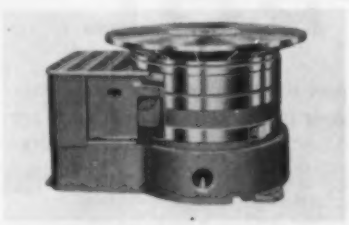
is offered in single inlet unit or with dual pipe connections where supply and return of gases or liquids are required within the same unit. Positive sealing principle uses monel bellows, keeping sealing surfaces parallel and leakproof. Handles water, air, vacuum, gases and industrial fluids on applications up to 250 psi and steam up to 150 psi, temperatures up to 500 F without adjustments. The revolving connection that forms positive seal between stationary supply line and revolving equipment is shipped from stock in pipe sizes ¼ through 3 in. with right- or left-hand threads. Machine threads furnished for speeds over 600 rpm. **Perfecting Service Co, 332 Atando Ave, Charlotte, NC.**

Circle 308 on Reader Service Card

Static adjustable-speed drive

is available in standard ratings from 1/20 to ¾ hp, with standard speed range of 8:1. For intermittent duty, device can be operated over wider range. Basic control module combines silicon-controlled rectifier and encapsulated circuitry. Module, along with suitable potentiometer and disconnecting means, constitutes complete control for starting, stopping and adjusting speed of dc motor. Silicon-controlled rectifier converts ac to controlled dc for stepless operation of fhp motor. Said to operate under extreme environmental conditions and to be shock- and vibration-resistant. Designed for operation on 115 v, 50/60 cps, single-phase power supply, but can be operated from any standard voltage with suitable transformer. **General Electric Co, Schenectady 5.**

Circle 309 on Reader Service Card



Turret indexing-machine chassis . . .

is packaged, heavy-duty basic unit, including motor, drive and clutch, around which special automatic machines can be designed and built. Provides intermittent motion for multiple-station automatic assembly operations. Wide selection of speeds, turret diameters and index positions are available. Standard chassis is furnished with 6 to 32 work stations and turret diameters from 48 to 72 in. Index/dwell sequence is accomplished by cross-over cam, which engages cam followers mounted on underside of index table. During dwell period, turret is locked by hardened steel block, said to achieve alignment accuracy and extra stability during work cycle. Main index camshaft is extended, providing means for mounting operational cams to actuate tooling or for mounting timing cams for electrical initiation of tooling sequences. Shaft extension can also be utilized to actuate auxiliary camshafts. **Swanson-Erie Corp, 814 E 8th St, Erie, Penna.**

Circle 310 on Reader Service Card

Single-circuit contact block . . .

with convertible terminals is available separately or with selection of pushbutton operators, signal lights and knob-, key- and coin-actuated selector switches. Contact blocks can be mounted in any combination desired to obtain required contact arrangement. All units are heavy-duty, oil-tight and dustproof, built to JIC and NEMA standards. **Mackworth Rees Inc, 1573 E Forest Ave, Detroit 7.**

Circle 311 on Reader Service Card

Cellular-sponge sealing grommet . . .

which can be molded of plastisol in any size, shape or dimension to suit any situation, is said to eliminate sound and vibration, as well as seal out water, moisture, mud, dust, gases and fumes. Hook-in, snap-in grommet with spring steel retaining tabs achieves positive seal between grommet membrane and sheetmetal. Membrane expands 300 to 400% to provide effective seal around wires, conduit tubes, pipe or cable. Said not to deteriorate in heat or cold, not to absorb water, to act as corrosion and electrical insulator and to prevent chafing, cutting, shorting and rattling. Most configurations range from $30 to $42 per 1000. Available in various elastomeric insulating materials to meet specific requirements. Delivery, within 4 wk. **Automotive Rubber Co, 12550 Beech Rd, Detroit 39.**

Circle 312 on Reader Service Card

Decade tubes count . . .

up to 100,000 units per sec and visually display total on tube faces, which, placed on series-connected decade counters, can be read in units, tens, hundreds, etc, during operation. Tubes record and indicate count on 10 glowing cathodes in luminescent dials within tubes. For use in auto-

continued on page 92

RADIATION CONTROL

AccuRay® instrumentation is based on the radiation of gamma rays from a source unit containing radium-226 or cesium-137. Source units are effectively shielded by housings cast in Meehanite by Hamilton Foundry. The density, and soundness of Meehanite castings provide the positive protection essential for safe and reliable instrumentation.

When buying castings, the skill and integrity of Hamilton Foundry is your best insurance that specifications—and delivery schedules—will be met.

**AccuRay is the registered trade mark of Industrial Nucleonics Corporation*

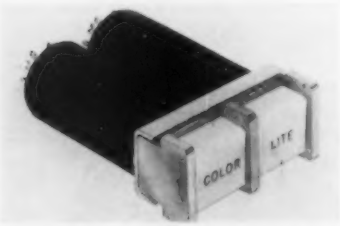
GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY INC.

1551 LINCOLN AVENUE • HAMILTON, OHIO • TWinbrook 5-7491

matic machine-tool programing and control and for high-speed processes such as coil and transformer winding, tube's count is converted to electrical pulses for readout. CK6909 and CK6910 decade counters operate up to 100 kc and CK6802 and CK6476 operate up to 4 kc. Tubes are cold-cathode, bidirectional, ring-stepping devices featuring low dissipation and short resolution time. **Industrial Components Div, Raytheon Co, 55 Chapel St, Newton, Mass.**

Circle 313 on Reader Service Card



Lighted pushbutton switch . . .

for dry circuit to 3-amp operation, is available in single pole to 6 pole, double- or single-throw models. Combines control switch and indicator light in pushbutton and utilizes standard, midget-flange, single-contact bulbs. Mounts on 1-in. centers, horizontally or vertically. **Color-Lite Div, Sloan Co, 7704 San Fernando Rd, Sun Valley, Calif.**

Circle 314 on Reader Service Card

Miniature relief valve . . .

is said to eliminate overtravel, chatter and slamming while maintaining system pressure. Rated for 100 to 4000 psi with wide adjustment, flow rate of 0.5 to 6 gpm, temperatures of −65 to 250 F. Valves, which weigh as little as 0.35 lb, offer wide variety of port sizes, male and female, straight-flare or bulkhead. Many sizes are now available as shelf items. Reported to exceed requirements of MIL-V-5523 with zero leakage internally. **Benbow Mfg Corp, 11920 Jefferson Blvd, Culver City, Calif.**

Circle 315 on Reader Service Card

Silicon tunnel diodes . . .

extend range of peak current levels previously available (1 to 22 milliamp). Increased outputs are combined with simplified circuitry in the new devices. The 14 types available offer peak currents ranging from 470 microamp to 100 milliamp. Standard units are available with ±10% peak-current tolerance and range in price from $12.50 to $19 in quantities of 1 to 99. "A" versions feature ±2% peak-cur-

continued on page 96

Masland Duran CLAD on the
Frigette Auto Air Conditioner by
FRIGIQUIP CORPORATION
Oklahoma City, Oklahoma

Helps speed production . . . and product sales, too

Masland Duran CLAD vinyl finish

This versatile vinyl can be laminated to metal to provide a built in finish that eliminates dipping, spraying, coating, etc. It can be cut, crimped, drilled and even deep-drawn without impairing its colors or designs. Easy to clean colors. A powerful competitive advantage for *your* product.

Write for information and samples . . . and the name of the laminator in your area.

Industrial Products Division
THE MASLAND DURALEATHER COMPANY
Dept. PE, Amber & Willard Sts., Philadelphia 34, Pa.

CIRCLE 93 ON READER SERVICE CARD 93

Belleville

Compression

Conical

Die

Discs

Drawbar

Energy Cartridge

Extension

Flat

Garter

Hairsprings

Helical

Hourglass

Power

Spiral

Starter

Swivel End

Torsion

Valve

Variable Pitch

Volute

springs

and other things

custom-made to quality standards

Answer your "where to get it" questions– by calling on the versatile experience represented by these typical springs and stamped parts. Here is unusual ability to analyze your part from both design and production efficiency and to make cost-saving contributions where possible. Whether your requirements are large or small, routine or extreme precision, you'll get a better brand of service and quality from the best springmakers in the business.

Send for "Pocket Guide to Springs and Other Things" —a quick picture of our products and services.

Assemblies

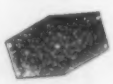
Catches

Clamps

Clips

Electronic Coils

Fasteners



Plates

Retainers

Stampings

Terminals

Washers

Wire Forms

6003

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
F. N. Manross and Sons Division, Bristol, Conn.
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
Cleveland Sales Office, Cleveland, Ohio
Chicago Sales Office, Chicago 46, Ill.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Mattoon, Ill.
Milwaukee Division, Milwaukee, Wis.
Seaboard Pacific Division, Gardena, Calif.

Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

With Extras . . . At No Extra Cost

1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
3. HARD CHROME PLATED CYLINDER BORES AND PISTON RODS for greater protection and reduced wear.
4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

Specify the

T-J Spacemaker

for longer, more efficient cylinder service

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

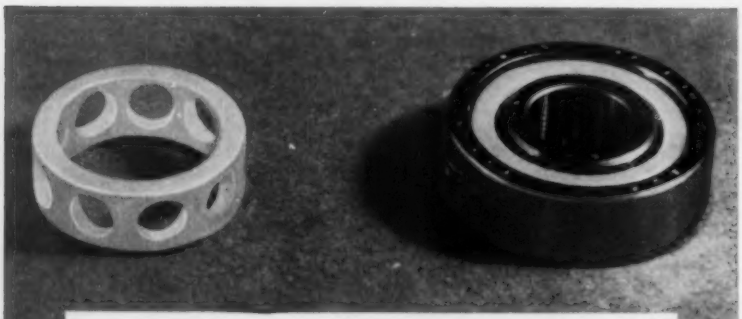
The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J TOMKINS-JOHNSON

RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

CIRCLE 95 ON READER SERVICE CARD

Oil-filled **NYLASINT**® parts retain lubricant while spinning at 1000 Gs



Ball bearing retainers of oil-filled "micro-porous" Nylasint will not bleed under extremes of temperature, pressure and acceleration.

These permanent built-in lubrication properties of Nylasint sintered nylon were demonstrated on ball bearing retainers (above) which operated over 10,000 hours under severe load conditions with no additional lubrication . . . and without loss in performance.

Micro-porous Nylasint parts absorb and retain fluids up to 50% by weight to minimize friction in bearing and wear applications. Almost 20% of the initial oil is retained at 15,000 Gs.

As an ink-filled roller, Nylasint has all the desirable mechanical surface characteristics of nylon while holding a large amount of ink which can be fed uniformly.

Inert fillers also can give resilient Nylasint parts outstanding dimensional stability and high load capacity . . . important for such diverse fields as missile components and steel office furniture.

For complete technical data on Nylasint, call or write for new Nylasint Bulletin BR-1111.

POLYPENCO®

INDUSTRIAL PLASTICS

Halex Corporation

a subsidiary of The Polymer Corporation

Reading, Pa.

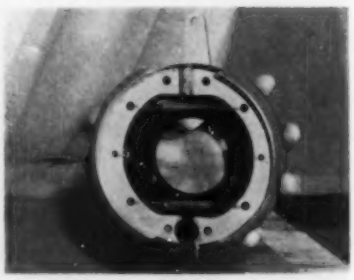
rent tolerance and are priced from $17.50 to $26.60. Extended-range tunnel diodes are said to have excellent uniformity and stability in operating temperatures of −121 to 392 F. Units are encased in miniature JEDEC TO-18 packages. **Semiconductor Div, Hoffman Electronics Corp, 3761 S Hill St, Los Angeles.**

Circle 316 on Reader Service Card

Continuous-threaded studs . . .

are available from stock in standard sizes in lengths up to 12 ft. Special sizes, lengths and materials can be furnished to order. **Highland Machine Co, 3215 Superior Ave, Cleveland 14.**

Circle 317 on Reader Service Card



Midget shoe-type brake . . .

is mechanically actuated, internally expanding unit that provides double the braking power necessary to stop a 500-lb midget racer and driver when traveling at 60 mph. Measures 6 x 1¼ in. and weighs less than 4 lb. Suitable for light vehicles and industrial machines. **Products Div, Bendix Corp, South Bend, Ind.**

Circle 318 on Reader Service Card

Custom plastic extrusions . . .

are available in any color, shape or degree of hardness required. Specialized extrusions for unusual applications also combine plastic and other materials, such as strap steel, wire, jute, twisted kraft and fiber cord. **Sackner Products Inc, 901 Ottawa Ave NW, Grand Rapids, Mich.**

Circle 319 on Reader Service Card

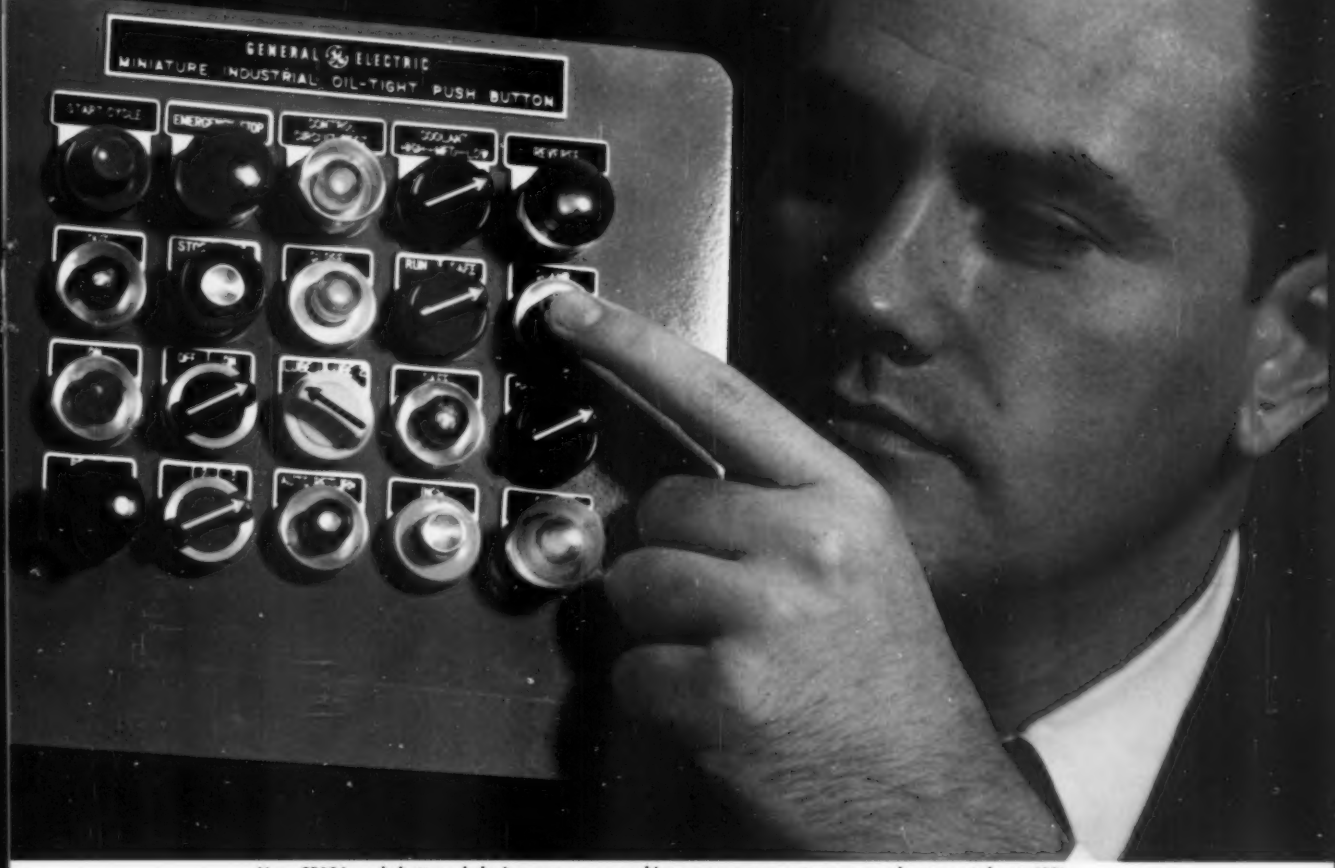
Fan-cooled induction motor . . .

is totally enclosed unit originally designed as driving unit for fuel, air and hydraulic pumps for aircraft. Continuous-duty, 0.03-hp motor operates at 10,000 rpm and is said to conform to applicable portions of MIL-M-7969A and MIL-E-5272A. Operates on 115-v, 400-cps, three-phase power. Full-load torque is 3 in.-oz; starting torque is 400% of full-load torque. Efficiency is reported to be 66.6%. Unit

continued on page 100

New

Another Measurable Advantage from General Electric Control



New CR104 push buttons help improve your machine appearance, cut your panel space at least 40%.

FIRST COMPLETE LINE OF INDUSTRIAL MINIATURE OIL-TIGHT PUSH BUTTONS

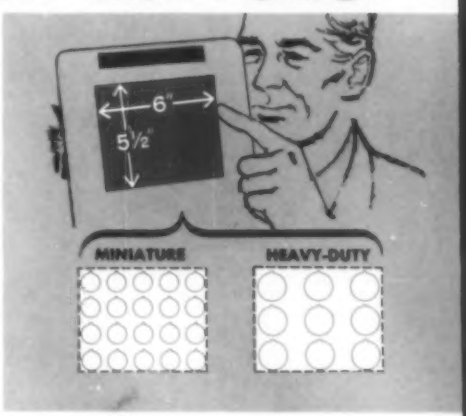
• Push buttons • Selector switches
• Illuminated push buttons • Indicating lights
• Push-to-test lights

Now you can design entire panels with miniature pushbutton units and cut your panel space requirements at least 40 per cent! General Electric announces the development and immediate availability of industry's first complete Industrial Miniature Oil-tight Pushbutton line.

This new CR104 line offers you the operating and functional units presently available in heavy-duty oil-tight forms —with an attractive appearance that enhances the design of your machines. A wide variety of operators is available, plus various modifications, special units, and nameplates to meet every operating requirement. Color coding is available in *both* operators and rings to provide you the flexibility of many different color combinations. Also, enclosures and pendent stations are available to accommodate from four to 42 units.

FOR MORE INFORMATION on this outstanding new development in control—and the "measurable advantages" it offers you—contact your nearby G-E Apparatus Sales Office, or write for Bulletin GEA-7127, General Electric Co., Schenectady 5, N. Y. 811-10

You get
MEASURABLE ADVANTAGES
WITH GENERAL ELECTRIC CONTROL



SAVE PANEL SPACE. Twenty new General Electric miniature units fit into the exact space required for nine heavy-duty oil-tight push buttons.

GENERAL ELECTRIC

NO. 8 OF A SERIES

"How to Design Welded Aluminum Structures"

Alcoa Tests Determine Fatigue Strength of Aluminum Alloy Weldments

Mr. Harry N. Hill, *Engineering Design Division Chief, Alcoa Research Laboratories, Aluminum Company of America, reports findings presented at the 1959 annual meeting of the American Society of Civil Engineers.*

In previous articles in this series, we have talked about the behavior of aluminum alloy weldments under a single load application. We have seen how the yield strength, tensile strength and compressive strength are influenced by the location and orientation of the weld—that is, by the design.

Design and configuration are even more important when a weldment must withstand many repetitions of loading without fracture. Fatigue failures have a habit of seeking out local regions of high stress. Frequently, these regions are not suspected.

An extensive fatigue testing program is being conducted at Alcoa Research Laboratories to evaluate the effect of various joint configurations on fatigue strength. Two general conclusions can be drawn from results of tests to date:

1. *The configuration of a welded joint has much greater influence on its fatigue strength than does the alloy of which it is made.*

2. *Fatigue strength is seriously impaired by abrupt changes in section and eccentricities that produce local bending.*

Figure 1 shows the results of fatigue tests of transverse butt welds in a high-strength aluminum-magnesium alloy. In these tests the stress in a cycle varied from zero to a maximum tension and back to zero. Even though the weld beads were reasonably smooth, the fatigue strength was materially improved by dressing the weld bead smooth with the surface of the plate.

More frequently than not, service loads consist of a fluctuating "live" load superimposed on a static "dead" load. In such cases the minimum stress in the cycle is something greater than zero. Fatigue strength for this kind of repeated loading is increased, as shown in Figure 2.

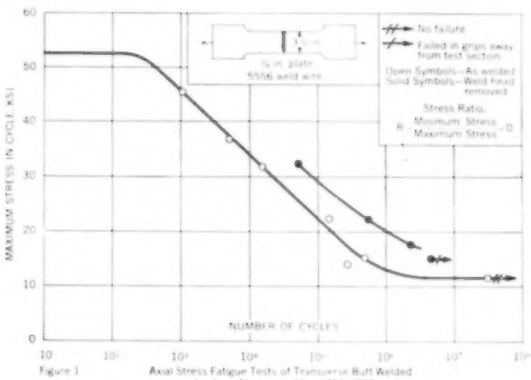

MAXIMUM STRESS IN CYCLE, KSI
NUMBER OF CYCLES
No failure
Failed in grips away from test section
Open Symbols—As welded
Solid Symbols—Weld head removed
Stress Ratio, R = Minimum Stress / Maximum Stress = 0
½-in. plate
5556 weld wire

Figure 1 Axial Stress Fatigue Tests of Transverse Butt Welded Joints in Aluminum Alloy 5456-H321

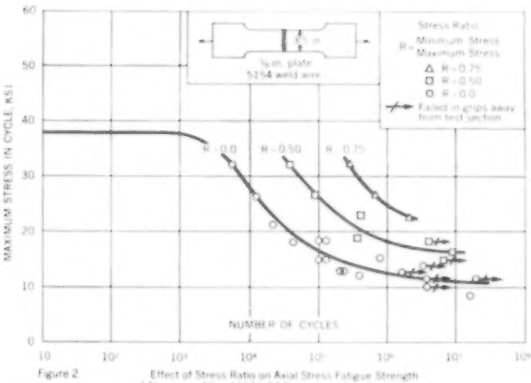

MAXIMUM STRESS IN CYCLE, KSI
NUMBER OF CYCLES
Stress Ratio, R = Minimum Stress / Maximum Stress
R = 0.75
R = 0.50
R = 0.0
Failed in grips away from test section
½-in. plate
5154 weld wire

Figure 2 Effect of Stress Ratio on Axial Stress Fatigue Strength of Aluminum Alloy 5154-H34 Transverse Butt Welded Joints

This article concludes the series. We hope the material presented has been helpful to those concerned with designing welded aluminum alloy structures. Much research work still remains to be done, so the program at Alcoa Research Laboratories will continue in the future.

For top-quality aluminum welding products such as consumable electrodes, welding and brazing rods and fluxes, and solder and soldering fluxes, contact your nearest Alcoa sales office. For more complete information on "Designing Welded Aluminum Structures," write Aluminum Company of America, 1760-J Alcoa Building, Pittsburgh 19, Pa.

ALCOA ALUMINUM
WELDING MATERIALS

HYDRA-DRIVES
BDB
Transmission

- Four speeds forward and reverse.
- Full power shifting.
- For equipment up to 175 h.p.

HYDRA-DRIVES
Torque Converter

- 3-to-1 torque multiplication.
- Available separately, or with Hydra-Drives Transmission.
- For vehicles up to 500 h.p.

HYDRA-DRIVES
CDB
Transmission

- Four speeds forward and reverse.
- Power shift in each range both forward and reverse.
- For equipment up to 250 h.p.

PEAK POWER OUTPUT FOR HEAVY-DUTY EQUIPMENT...

Hydra-Drives®

Power Shift Transmissions and Torque Converters

Rockwell-Standard's Hydra-Drives units make hard work easy for heavy-duty equipment. The result . . . smooth, efficient, economical operation. A torque converter and 4-speed transmission in one compact package, the Hydra-Drives Power Shift Transmissions have been proved in hundreds of vehicles. They eliminate engine lugging and heavy shock loads. A 3-to-1 torque multiplication makes starting fast and effortless – even with heaviest loads.

Just a flip of the operator's lever accomplishes power shifts without interruption of the power flow. Automatic features of the converter and ease of power shifting simplifies operator training and lengthens vehicle life.

With four speeds forward and reverse, the Hydra-Drives Power Shift Transmissions are ideally suited for vehicles which must travel in both directions during a normal work cycle.

Hydra-Drives Torque Converters are the simplest, most efficient made. They can be matched with any transmission for easier, more efficient operation.

Another Product of...

ROCKWELL-STANDARD CORPORATION

ROCKWELL R STANDARD®

Transmission and Axle Division, Detroit 32, Michigan

CIRCLE 99 ON READER SERVICE CARD 99

ROTARY AIR
GAST
PRODUCTS

VACUUM or PRESSURE . . .

For O.E.M., lab or plant use—specify compact, portable integral-motor

GAST rotary vane AIR PUMPS

Gast construction is precise—and prices are competitive!

To save space . . . and reduce weight and mounting costs—use Gast Integral-Motor-Pump Models! For vacuum use—or fitted as air compressors—four sizes offer capacities from ½ to 3.8 cfm.

For completely oil-free air, Models 0406 and 0211 are available with oil-less construction (optional). Lubricated Models 0321 and 0521 have fan cooling. Vacuum ranges to 28" Hg., pressures to 25 psi.

Rotary-vane design is positive in displacement, quiet and long-lived. That's why engineers specify Gast Air Pumps as components for air sampling, industrial and laboratory instruments; printing, packaging and vending machines.

To acquaint yourself with other advantages, write for Bulletins V-P-356.

GAST MANUFACTURING CORP., P. O. Box 117-V Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE & A.S.M.E. CATALOG

GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

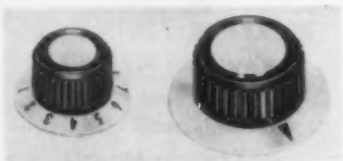
is said to withstand severe environments. Weighs 1 lb 0.75 oz. **Hertner Electric Co, sub of Kearfott Div, General Precision Inc, Little Falls, NJ.**

Circle 320 on Reader Service Card

Ultrahigh vacuum couplings . . .

are said to permit no leaks detectable or measurable on helium mass spectrometer with sensitivity of 1.7×10^{-10} atmos cc/sec/division. All-metal unit is operable at elevated temperatures. Presently available in sizes for ¼ through ¾ in. OD tube. **Cajon Machine Co, 902 E 140th St, Cleveland 10.**

Circle 321 on Reader Service Card



Stock knobs are molded . . .

in four standard sizes from thermosetting phenolic or urea materials per MIL-P-14 specifications. Each knob is available with nickel-plated brass inserts for ¼ or ⅜ in. dia shafts, with two socket setscrews. Aluminum decorative inserts or skirts can be etched and filled to specifications and are available in various anodized finishes, plain or radially spun. Offered in sizes ⅜ in. high x ⅝ in. dia; ⅝ in. high x ⅞ in. dia; ⅞ in. high x 1¼ in dia; 1 in. high x 1¾ in. dia. Also available with skirts. Skirt dia for the four knobs are 1⅛, 1¼, 1⅜ and 2½ in., respectively. **Rogan Bros, 8025 N Monticello Ave, Skokie, Ill.**

Circle 322 on Reader Service Card

Pressure-sensitive nameplates

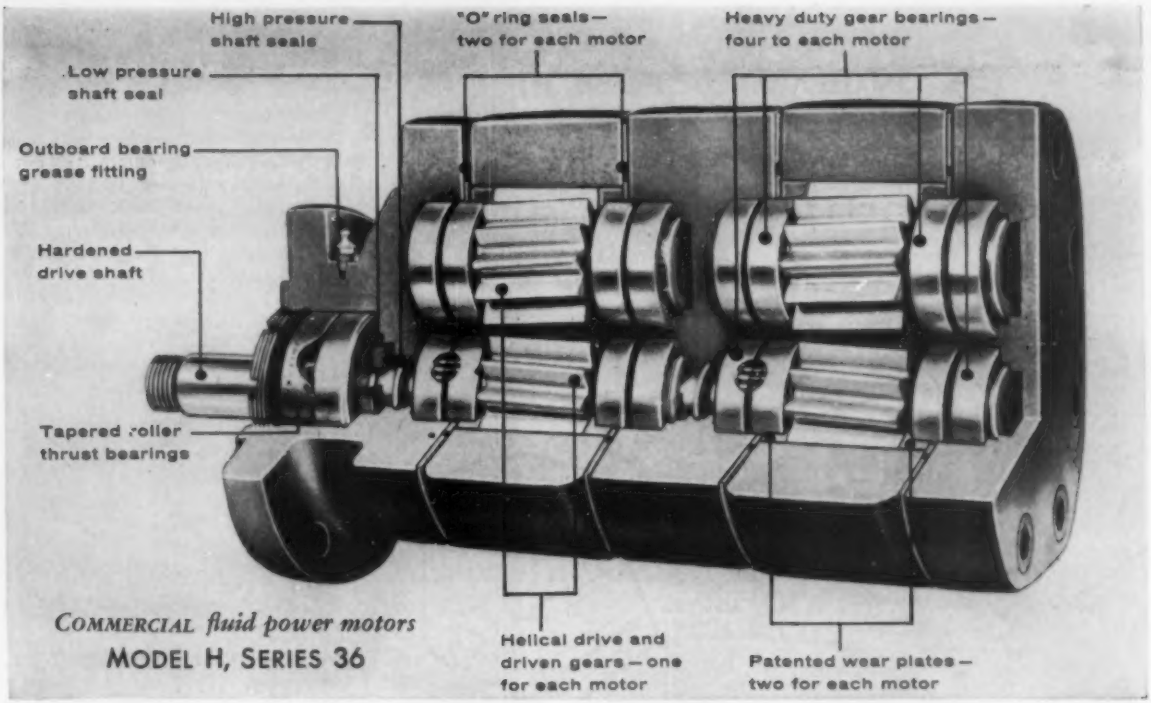
are available in flat or embossed metallic foils, printed in as many colors as required. Utilize permanent adhesive, which, once in place, cannot be removed. Can be used on metal, plastics, ceramics and wood. Said to withstand below-zero and near-tropical temperatures. Affixes to products without drilling, screws, moisture or heating, solvents or preparations. **Allen Hollander Co Inc, Dept 41-79, 385 Gerard Ave, New York 51.**

Circle 323 on Reader Service Card

Stainless, low-torque retainer

is utilized in series of 48 instrument ball bearings. Made in industry-standard sizes R2, R3 and R4 sizes, retainer is said to reduce internal friction to min. Two sections of retainer are crimped together with

continued on page 102


High pressure shaft seals
"O" ring seals—two for each motor
Heavy duty gear bearings—four to each motor
Low pressure shaft seal
Outboard bearing grease fitting
Hardened drive shaft
Tapered roller thrust bearings
COMMERCIAL fluid power motors
MODEL H, SERIES 36
Helical drive and driven gears—one for each motor
Patented wear plates—two for each motor

How to get multiple "speed-torque" output

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

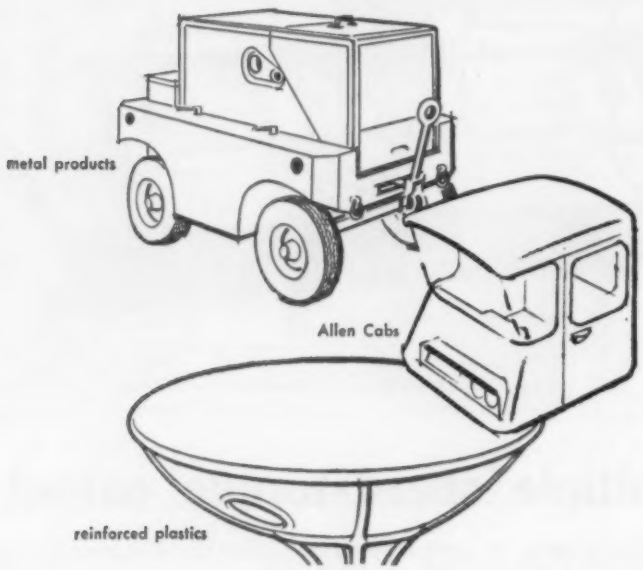
Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is help and assistance from COMMERCIAL's technical service department.

Address inquiries to Commercial Shearing & Stamping Company, Dept. G-39, Youngstown 1, Ohio.

COMMERCIAL
shearing & stamping

A NEW NAME
for a long-established, expanding company



STOLPER INDUSTRIES

Stolper Steel Products Corporation has made a constant effort to offer a complete service to industry . . . to keep abreast of modern trends in materials and methods . . . which now dictates a new corporate arrangement, a new corporate name: Stolper Industries, Incorporated.

In 1908 Stolper started its reputation for fine sheet metal parts and products made exclusively to customer specifications.

To this, the **Allen Division** was merged, with its unusual background of experience in the design and manufacture of operator cabs for industrial, farm and construction equipment; plus an unequaled reputation in military winterization.

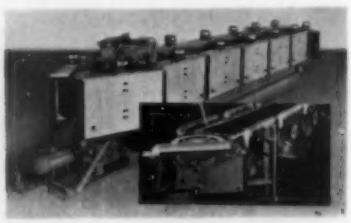
Now **Plasticon Incorporated** has been added, an equally experienced division manufacturing reinforced plastics parts for the agricultural, automotive, and aircraft industries.

To benefit from the full breadth of Stolper Industries' design, engineering, and manufacturing services, write us now. There's no obligation, of course.

STOLPER INDUSTRIES
INCORPORATED
306 Pilgrim Road • Menomonee Falls, Wisconsin

predetermined degree of looseness so that they are able to move slightly relative to each other. This results in reduced starting torque. Made to precision tolerances of ABEC Class 7, bearings are available with flanged outer ring, single or double shields, and as duplexed or preloaded pairs. For high-speed applications, bearings are made with one-piece, paper-base phenolic retainer. OD ranges from 0.375 to 0.625 in., with bores from 0.125 to 0.250 in. **Miniature Precision Bearings Inc, Keene, NH.**

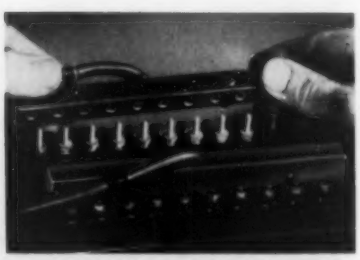
Circle 324 on Reader Service Card



Multipurpose indexing conveyor . . .

with horizontal and vertical platen is available in rectangular and straight-line design. Has electrical brake and clutch controls, which allow either continuous drive or variable station dwell operation. Platens are butted together and bolted to two traversing chains, forming a seal with one another and protecting roller supports, drive chains and guides from abrasives and dirt. Conveyor has AGMA-rated geardrive. Sprocket bearings are sealed, antifriction and flange-mounted. Fixtures may be mounted vertically, horizontally or both. They can be fixed, continuously revolving or cam-indexed, with choice of clockwise or counterclockwise tuning. **Murray-Way Corp, PO Box 180, Birmingham, Mich.**

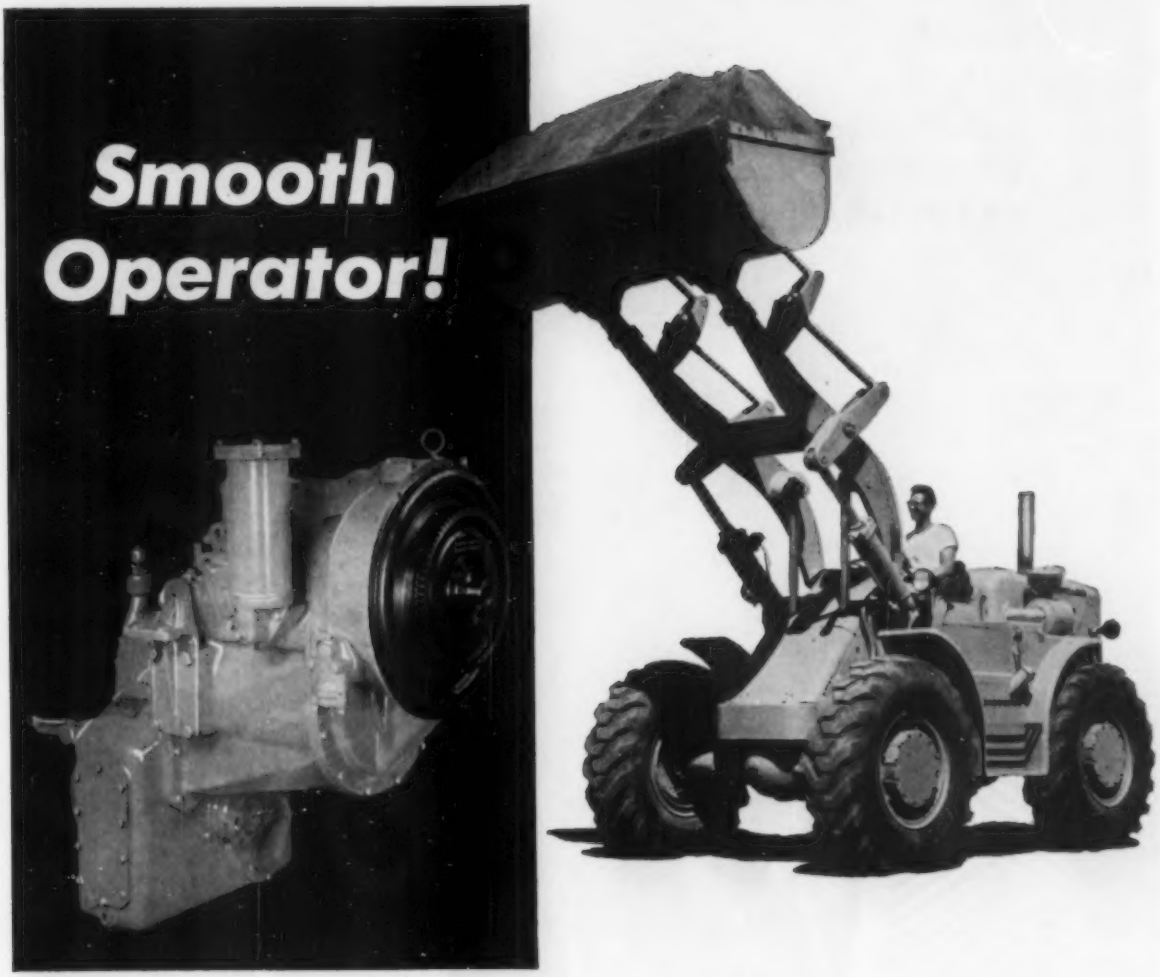
Circle 325 on Reader Service Card



Connector for terminal strips

makes connections to an entire row of studs in terminal strip in single operation. Can be used as permanent connector or as tool for use with production circuit-checking equipment. Stock sizes offer terminals (from 4 to 16) to fit No 6 and No 8 studs. Terminals in connector are said to be self-positioning and to cor-

continued on page 104



Cat's new wheel Traxcavator features fast-working power-shift transmission with Twin Disc Torque Converter

Time was when wheel-type loaders were viewed with scorn as little more than overgrown agricultural machines. But in the years since World War II, the wheel loader has gained universal favor with construction men. Its speed and mobility have proved to be real production-boosting advantages in many types of loading jobs.

Now, after years of research and engineering plus more than 14,000 machine test hours, the 944 Traxcavator — first wheel loader to bear the famous Caterpillar trademark — has made its appearance.

There's no need to enumerate the 944's many design and performance features. These have been given wide coverage in all the construction magazines. It is worth pointing out, however, that the new wheel loader, like so many other Cat machines, is equipped with a Twin Disc Torque Converter.

The torque converter — a single-stage Type 6 model — works in conjunction with the 944's two-speed forward, two-speed reverse, planetary transmission. Each of these four in-line gear trains has its own clutch. Two of the planetary trains are for direction control while the other two provide gear speed selection. Reverse speeds are 25% faster than forward—a key factor in reducing cycle time. The torque converter assures smooth, instantaneous clutch engagement by absorbing the shock of the shift in its fluid circuit.

Caterpillar is one of many well-known manufacturers who specify Twin Disc Torque Converters for their power-shift transmissions. If plans for a power box are on your drawing board, you'll find the torque converter you need in the complete Twin Disc line. Write our Rockford office for new Bulletin 510.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin. Hydraulic Division: Rockford, Illinois.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Torque Converters

CIRCLE 103 ON READER SERVICE CARD 103

Don't let adaptation and compromise determine your gearing specifications. Custom-made gears and gear boxes from Cincinnati Gear are competitively priced—yet, they afford the design engineer full freedom to incorporate the exact transmission components he requires to suit his specific need.

Send for NEW 32-page Technical Brochure

CINTI®

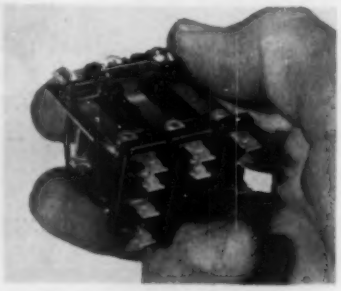
THE CINCINNATI GEAR CO.

Wooster Pike and Mariemont Ave. Cincinnati 27, Ohio
Custom Gear Makers Since 1907

GEARS, good gears only

rect for misalignment of studs in terminal strip itself. **Autotron Inc, PO Box 2278, Santa Monica, Calif.**

Circle 326 on Reader Service Card



Low-cost power relay . . .

is said to offer high contact rating (10 amp at 115 v ac) for its small size. Contact arrangements are available up to and including 3PDT, with coil voltages up to 230 v ac or 115 v dc. Relay features 3/16-in. quick-connect or solder terminals on front panel and, if desired, on coil. **Warco Industries, 6625 Delmar Blvd, St Louis 30.**

Circle 327 on Reader Service Card

Magnetic reed switch . . .

for use in limit and position indicators and various types of relays, operates in any position and is hermetically sealed. Rated at 15 v-amp max, resistive up to 1 amp, up to 250 v. Arrangements can be normally open, normally closed with bias magnet and latching arrangement. OD of tube is 0.2 (±0.015 in.) in. Over-all length with 0.05 in. dia rod flattened at ends is 3¼ in.; with flats removed, it is 2 7/16 in. **Hamlin Inc, Lake and Grove Sts, Lake Mills, Wis.**

Circle 328 on Reader Service Card

15-in.-dia rotary table . . .

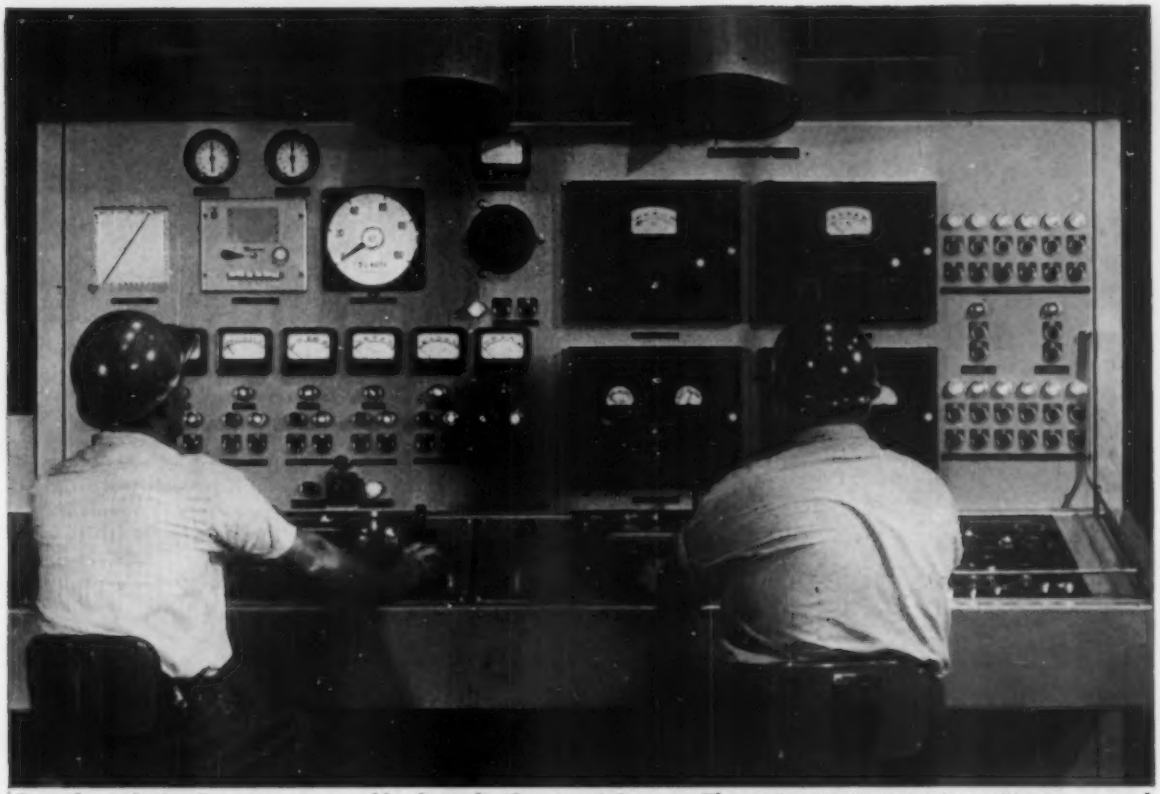
offers indexing of each degree (360 indexes), free rotation of table, worm feed reading to 1 sec of arc, tolerances of ±10 sec. Accompanying each table is No. 5 Morse taper hardened and ground locating center to fit table to concentricity of 0.0001 in. error max. **Morey Machinery Co Inc, 383 Lafayette St, New York 3.**

Circle 329 on Reader Service Card

Digital counters and timers . . .

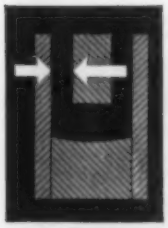
reset to zero and continue counting when max range is reached. Provide up to three electrical, decimal outputs. Timers are similar to counters, but contain tim-

continued on page 106



Control panel of a Carpenter consumable electrode (Consumet) furnace. Electronic circuits maintain positive arc control and precise electrode movement to assure the ultimate in refining.

Where *Carpenter's* "big inch" makes a mile of difference in alloy quality



The "big inch" in Carpenter's consumable electrode (Consumet®) furnace is the extra space between the consumable electrode and the mold wall. (Conventional furnaces of this type are almost ⅓ smaller at this vital point.) The "big inch" in Carpenter's furnace provides more exhaust space to carry off harmful gases. It also gives Carpenter technicians more precise vacuum control during the arc strike as well as during the entire melting process. As a result, you get cleaner, more uniform alloys from core to surface. Segregation and variation in grain size are minimized . . . to assure you consistent, predictable performance from your vacuum melted alloys. The "big inch" is only one of many exclusive Carpenter quality controls in consumable electrode, MEL-TROL® and vacuum-induction-melted (VacuMeltrol®) specialty steels. Ask your Carpenter representative for the full story behind these alloys and how they benefit you.

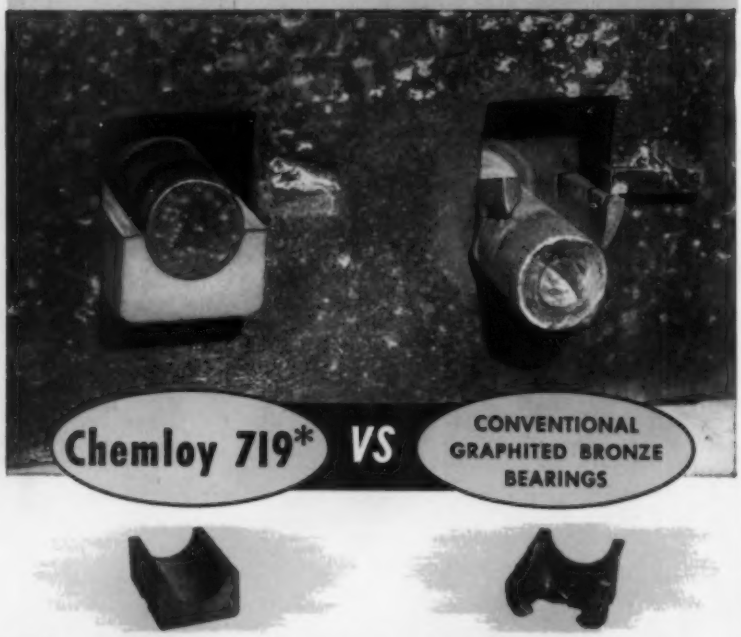
Carpenter steel

you can do it ***consistently*** better with Carpenter Stainless Steels for specialists

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

CIRCLE 105 ON READER SERVICE CARD 105

OVER 5 TIMES THE LIFE OF GRAPHITED BRONZE BEARINGS



This report comes from the insulating board division of a large paper company where Chemloy Dry Bearings are outlasting, outperforming and saving money over conventional graphited bronze bearings. They are used to support rollers turning continuously in kiln dryers where lubrication is not practical or possible. Operating temperature is 350°F., bearing loads approximately 25 psi. Figures based on a 3-year service record indicate a yearly savings of $6,000.00.

Here are the facts:

1. Chemloy Bearings will last more than 8 years, as against an 18 month life expectancy for graphited bronze.
2. Chemloy's lower coefficient of friction eliminates retainer strips and weldments required for each bronze bearing installation.
3. Reduction of stub shaft wear due to bearing failure.

   Plus increased safety to personnel and equipment through elimination of hazardous welding of retainer strips in a dust-laden atmosphere.

Put Chemloy 719 to work for you. Send b/p or specs. for engineering recommendations. Request Bulletin T-120 and price sheet on sheet, rod and tubing.

Crane Packing Company, 6445 Oakton Street, Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Company, Ltd., Hamilton, Ont.*

Chemloy Bearings in action. Weld marks at left show positions of retainers formerly needed to keep bronze bearings in position. 20,000 such weldments are eliminated in this instance.

*Chemloy is an exclusive engineered product of Crane Packing Co. It is the result of extensive research and development to produce a better bearing material.

*Best in DuPont Teflon Based Bearing Materials

John Crane

MECHANICAL PACKINGS | SHAFT SEALS | TEFLON PRODUCTS | LAPPING MACHINES | THREAD COMPOUNDS

CRANE PACKING COMPANY

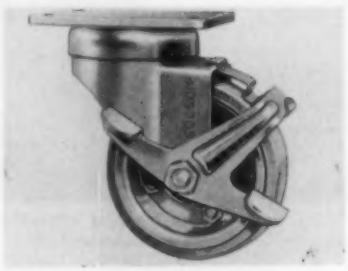
ing pulse source to drive timer. Both three- and four-digit models are offered, to give total range of 0000 to 9999; with wide variety of time resolutions, such as 1 min., 0.1 min., 1 or 0.1 hr or millidays. Prices start at $200. Availability is 4 to 8 wk. **Chrono-log Corp, PO Box 4587, Philadelphia 31.**

Circle 330 on Reader Service Card

Spring-set, solenoid-released brake for 40-frame motors . . .

has torque rating of 3 ft-lb. Available in ac and dc and with drip-proof enclosures. Unit has same over-all measurements of its predecessor, rated at 1 ft-lb. **Stearns Electric Corp, 120 N Broadway, Milwaukee 2.**

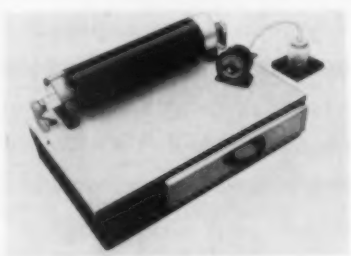
Circle 331 on Reader Service Card



Tread-lock brake . . .

for medium-duty casters with capacities from 175 to 400 lb provides brake action on all types of wheels by direct pressure on tread surface. Self-compensating brake-lock spring is said to retain full braking efficiency through wheel life. Brake-pedal arm is embossed and extends to horizontal leg of casting, increasing over-all brake strength and direct braking action. **Colson Corp, 7 S Dearborn St, Chicago.**

Circle 332 on Reader Service Card



Dry-process duplicator . . .

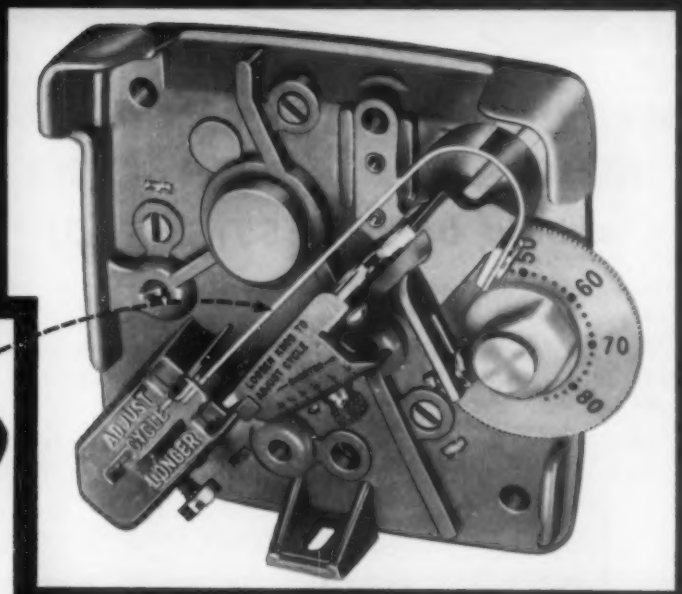
copies anything translucent in a two-step operation. Copies are made directly from the original on diazo-type dryprinting paper. Cost for 8½ x 11 in. sheet is less than 2¢. Single- or multicolor reproductions are possible in any size up to 11 x 17 in. Entire operation can be done in day-

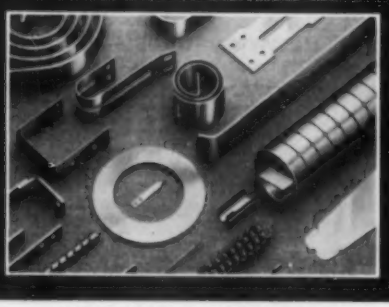
continued on page 108

General Plate TRUFLEX Thermostat Metal Assures

CONSISTENT SENSITIVITY AND ACCURACY...

In SIGNET CONTROLS





A few typical Truflex fabricated parts

In designing its new attractive thermostat Signet Controls turned to General Plate for Truflex Thermostat Metal. Here's how Mr. W. D. Gibson, Manager of Signet Controls, puts it:

"The heart of a thermostat is the temperature-responsive element. In designing our new Model T500 we were careful to select a thermostatic material which would be consistently sensitive and accurate. Our previous experience assured us that we would obtain these vital characteristics with Truflex Thermostat material."

When you buy General Plate Truflex Thermostat Metal you can be sure that the first lot meets specifications 100% and every succeeding lot is a duplicate . . . has identical characteristics to the original . . . whether it be manufactured days, months or years later.

Advanced General Plate production methods insure positive consistency in tolerances, grain structures, expansion, hardness, etc. They assure maximum uniformity of materials which reduces costly rejects and guarantees highest quality performance.

Truflex Thermostat Metals are available as fabricated elements, assemblies and extra long coils or flat strip. Write for information.

GENERAL PLATE PRODUCTS

TEXAS INSTRUMENTS
INCORPORATED
METALS & CONTROLS DIVISION
1009 FOREST STREET • ATTLEBORO, MASS.

General Plate Products: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

CIRCLE 107 ON READER SERVICE CARD 107

YOU CAN PUT YOUR FINGER ON
THE REASON

Why **"MARK-TIME" MECHANICAL TIMERS** *should be INVESTIGATED!*

Low cost mechanical Timers, Time Switches and Time Devices **can** be quite sophisticated. For example: they can be designed to ring bells, flash lights, turn valves, cut cords, start, stop or operate electrical or mechanical equipment, and to do all this **after** a pre-selected time period has elapsed.

The "Mark-Time" mechanical "memory" **cannot** fail due to an electrical failure since it is spring powered.

The "HEART" of the "Mark-Time" is of a new super-tough alloy which prolongs mainspring life indefinitely.

This new special steel virtually **eliminates** mainspring failure. This adds extra sales features to your product at no extra cost.

The "MARK-TIME" Mainspring is Unbreakable!

Tensile strength, durability and corrosive resistance is unexcelled. No other Timer on the market has these exclusive features.

At present, we manufacture more than 3,000 DIFFERENT kinds of custom-built timers for industrial, consumer and military applications. Thus, we are the **largest** manufacturer of mechanical timers in the **world**!

Research and development work welcome—small runs our specialty.

Sales engineers in 27 key cities at **your** service.

Write for your copy of this **new** Engineering Handbook on Timers, specifically written and illustrated for the Design and Development Engineer.

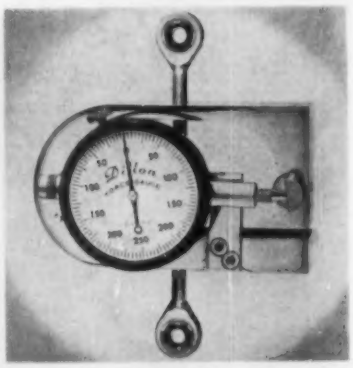
MARK-TIME

M. H. RHODES, inc.

HARTFORD 6, CONNECTICUT

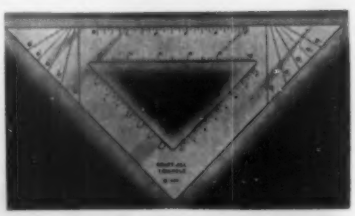
light. Machine is 20 x 10 x 9 in. high. Weighs less than 15 lb. Operates from any standard 110 v ac outlet. Cost is $89.50 complete. Separate timer is $15.00. Unit with built-in timer is $103.50. Copymaker Co, 3597 Lee Rd, Cleveland.

Circle 333 on Reader Service Card



Split-dial push-pull gage . . . gives readings of both tension and compression loads. Can be hooked to system to measure and control oscillating loads in tension and compression. Gages are individually calibrated in capacities from 5 to 25,000 lb. Accuracy guaranteed to ±1% of full-scale reading. All units can be supplied with optional microswitches. **WC Dillon & Co, 14620 Keswick St, Van Nuys, Calif.**

Circle 334 on Reader Service Card



Drawing triangle . . . combines protractor, straight edge and scales in one instrument. Permanently stamped into standard 8-in., 45/90° noncombustible plastic triangle are four scales —1, ½, ⅛ and 1/10 in.—as well as guide lines for construction of 90°, 75°, 60°, 45° and 30° line intersections. Price, $2. **Draft-All Triangle Co, 152 W 42nd St, New York 36.**

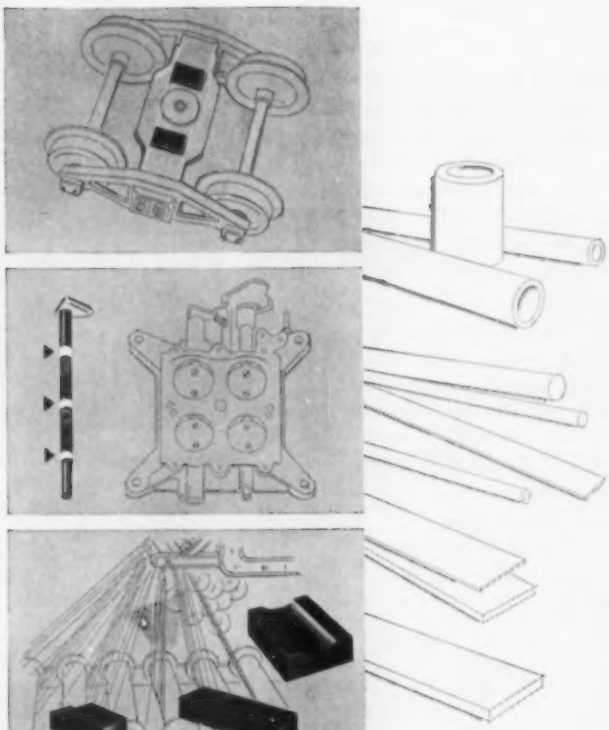
Circle 335 on Reader Service Card

Diffusion-transfer negative . . . combines camera and transfer copying techniques. Can be processed in single solution in any standard diffusion-transfer processor. Copies can be made same-size, reduced or enlarged. Available coated

continued on page 110

NEW TEFLON BEARINGS

for Non-lubricated Service



Railroad truck bearings (top), carburetor bearings (center), and saddle bearings for textile machinery (bottom)—fabricated from top-quality Teflon* stock by Garlock—offer performance unmatched by any other material.

Now—new bearings of Teflon eliminate lubrication . . . resist extreme temperatures and reactive chemicals . . . drastically reduce downtime.

No finer combination of properties. Bearings of Teflon offer a lower coefficient of friction than any other solid material; they have exceptional thermal stability and are suitable for continuous service to +500°F; they are completely resistant to nearly all chemicals and solvents; they are tough, abrasion-resistant, have no moisture absorption.

Applied where safety and reliability are essential. Teflon is used as journal and thrust bearings, and on other sliding surfaces where lubricated bearings are undesirable, or incapable of operation in extreme temperatures or corrosive conditions, or where there is a possibility of lubricant failure. Teflon bearings afford unexcelled performance where slip-stick motion must be minimized . . . on reciprocating and oscillating systems where the lowest possible static friction must be attained . . . where space and weight savings are essential.

Easily fabricated from high-quality Garlock stock shapes. Teflon bearings can be simply and economically made from standard Garlock tape, bar and rod stock available through local Garlock distributor outlets. Or, if you wish, Garlock will work to your exact specifications in furnishing bearings of all tolerances and size. Whatever the case, the key to best bearing performance is through the use of Teflon stock shapes by Garlock. With years of experience in research and processing of plastics, Garlock is able to recommend and furnish *exactly* what you need, when you need it, and at the lowest possible cost.

Find out more about Teflon bearings. Consult your local Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada.

Or, write for Plastics Catalog AD-177, Garlock Inc., Palmyra, New York.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

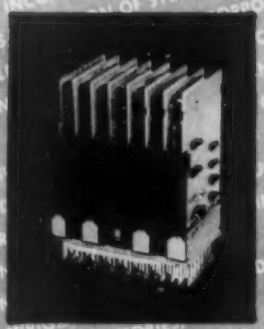
Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

*DuPont Trademark

CONSOLIDATED

CUSTOM MOLDING FOR "BLUE-CHIP" INDUSTRY



For more than eighty years, Consolidated Molded Products Corporation has been a preferred source of high-quality plastics requirements for America's top-ranking companies.

Consolidated is a complete plastics product supplier, small or large parts, compression or injection, thermosets or thermoplastics.

Product design and development to final inspection and shipment are all guided by Consolidated's tradition of craftsmanship, a pattern of consistently premium-grade, on-time production for great companies.

For YOUR tough job in plastics, call on Consolidated, FIRST.

Send for your free copy of our new 20-page Facilities Report

CMP

"Your Blueprint in Plastics" Since 1874

CONSOLIDATED MOLDED PRODUCTS CORPORATION

330 Cherry St., Scranton 2, Penna.

on waterproof-base stock for use with films and transfer-offset plates or 92-gram regular paper base for use with standard, colored, card, duplex and nonwaterproof transparent positive papers. **Ampto Inc, sub of Anken Chemical & Film Corp, Newton, NJ.**

Circle 336 on Reader Service Card

Shock-testing machine . . .

is for drop testing of electronic devices and other fragile equipment up to 150 lb in weight. Machine will find fragility of product itself and can also be used to test ability of cushioning material to meet military and commercial specifications. Tester weighs about 100 lb, is 68 in. high and occupies 14 x 16 in. floor space. **Hardigg Industries, S Hadley Falls, Mass.**

Circle 337 on Reader Service Card

Nylon thrust-washer kit . . .

contains over 100 washers in 39 sizes, $\frac{1}{32}$, $\frac{1}{32}$ and $\frac{1}{16}$ in. thick. Pocket-size kit is rigid plastic with separate compartments for each thickness. Washers are molybdenum disulphide-filled nylon formulation with uniform properties. Said to be free of flash lines and stress spots. $3. **Hardware Designers Inc, PO Box 4, S Hackensack, NJ.**

Circle 338 on Reader Service Card

CORRECTION

Price of air-operated actuator, reported Aug 15 '60, p 66 is $24 plus price of switch with which it is used. The $4 price published was a typographical error. **R B Denison Mfg Co, 386 Broadway, Bedford, Ohio.**

Pick a Number!

There are only four basic numbers in Fenwal's new "500" Line of Electronic Temperature Controllers and Indicators. But they provide industry with a broad choice of instrumentation *not available elsewhere!*

For example, a packaging machine manufacturer might have the problem of controlling 6 heater blocks on a unit capable of sealing a variety of films. He'd want separate control of each block — 3 "ON-OFF" and 3 proportioning — with remote adjustment of control. The Fenwal 536 Controller would give him all this. For indication during periodic checks, he'd simply add the 580 Indicator. *Price? Extremely reasonable!*

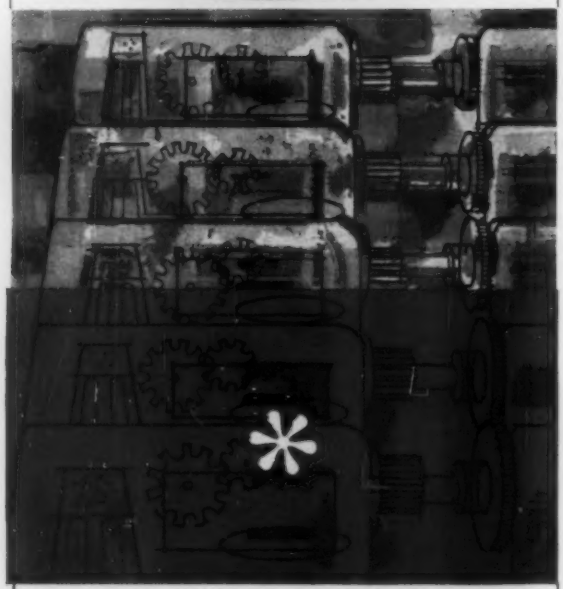
Again, a soap manufacturer might want either "ON-OFF" or proportioning control of four batch process tanks in separate plant areas — with control and indication at each point. He'd choose the Fenwal 561 Indicating Controller — a *stock unit*. He'd have no mounting problems. And with thermistor sensors, use ordinary lead wire to the supervisory panel. *As simple as that!*

Another manufacturer whose needs are only indication, might select the 582 Thermometer. And there are many *modifications* and *combinations* possible. Why not make *your* choice from these "Smarter Looking Smarter Acting" Fenwal Instruments? Write for Bulletin MC-190. FENWAL INCORPORATED, 30 Pleasant Street, Ashland, Massachusetts.

Another example of how

Fenwal CONTROLS TEMPERATURE . . . PRECISELY

add machinery
WITHOUT CAPITAL OUTLAY



USE *Spincraft* MACHINES WITHOUT INVESTING A DIME

More machines to produce more? Add production equipment without spending or borrowing or leasing.

Speed production output economically by letting Spincraft produce part of your product — or all of it — from start to finish.

Spincraft's metal-spinning facilities, craftsmen, and versatile equipment are designed to solve your problems. As the world's most experienced metal-spinning plant, Spincraft can bring to your metalforming problems solutions unavailable anywhere else.

Check Spincraft now for your stepped up production needs or metalforming problems.

Spincraft
SKILL WILL OUT

4151 W. State St., Milwaukee, Wisc.

Each month Spincraft sends its "Notes for An Engineer's File" to qualified personnel in industry. Write us if you would like to receive these valuable reports.

Save up to
25%
per installation with HOWELL
PART WINDING MOTORS

Why pay for unnecessary voltage-reducing motor-starter elements to limit inrush currents for low-starting-torque loads? Where your controller *doesn't need* transformers, resistors or reactors? . . . and requires only two half-size contactors?

You can save up to 25% when Howell *Part Winding Motors* go into your motor-control "package." You pay *little*, sometimes nothing more for the motor, you save a *lot* in control cost for jobs like these:

- Centrifugal pumps • Blowers
- Unloaded compressors • Fans
- *Any* low-starting-torque load

Call your HOWELL MAN for application counsel. A-2915A

- 10—300 hp, a.c.
- All enclosures
- All mountings
- All modifications
- NEMA designs B & C

Write for Bulletin 1030 (A, B)

HOWELL
electric motors company
Offices in principal cities . . . see **YELLOW PAGES**

CIRCLE 205 ON READER SERVICE CARD

Mastergauge by MARSH

Nothing could be finer!

Mastergauge alone brings you "Conoweld" leakproof, one-piece tube and socket; sturdier Marsh-alloy case; precision mastergauge movement; stainless tube and socket when required.
Mastergauge is standard bearer for the broad line of Marsh Gauges for every service.

Write for catalog

MARSH INSTRUMENT COMPANY
Division of Colorado Oil and Gas Corp.
Dept. 39, Skokie, Illinois
Marsh Instrument & Valve Co., (Canada) Ltd.
8407 103rd St., Edmonton, Alberta, Canada
Houston Branch Plant, 1121 Rothwell St.
Sect. 15, Houston, Texas

CIRCLE 112 ON READER SERVICE CARD

CIRCLE 206 ON READER SERVICE CARD

REPRINTS

Reprints currently available without charge are listed on the Reader Service Card bound in this issue. Single copy free; quantity prices on request.

The following special reports are available as long as the supply lasts, from Reader Service Dept., Product Engineering, 330 W 42 St, New York 36. Please enclose remittance with order; we pay postage.

R-48—Reinforced Plastic Parts
Combined reprint of 11 articles giving design data on the seven processes for commercial parts. 64 p. $2

R66—The European Engineer Talks
The challenge to American proficiency in design for production disclosed by interviews with technical directors in six countries. 24 p. $1

R16—Plate Cam Design
Series of 7 articles with complete design data; curve blending and profile synthesis to reduce inertia, 48 p. $1

R65—Reading, Writing, Reporting
Combined reprint of: 5 steps to faster reading; 8 steps to better writing; 7 steps to better reporting. 24 p. $1

R46—Manual of Reliability
How to design for reliability, human factors, statistical tools; implementing the program. 32 p. 50¢

R22—Engineering Organization
Study of 50 companies shows changes brought on by product planning. 24 p. 25¢

R21—Engineers' Bookshelf
Annotated bibliography of technical books for the design engineer. 24 p. 25c

R68—Encapsulating Systems
Up-to-date comparison of basic systems. 7 p. 25¢

R67—Heat Protectors for Motors
Response and accuracy of all types. 25¢

R64—Bonded Solid Lubricants
Data on new high heat types. 25¢

R63—Hydraulic Couplings for Geared Drives
How to soften shock and cut cost. 25¢

R62—High-speed Photography
How it can solve design problems. 25¢

R61—Angular Errors in Gearing
Equations predict seven effects 25¢

R60—Journal Bearing Design
New equations and design charts. 25¢

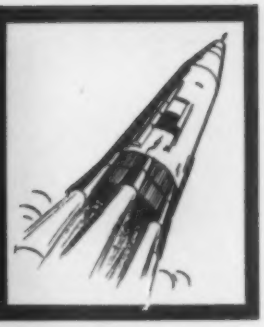
R58—How to Avoid Hose Failure
For metal hose; all known causes. 25¢

R57—Miniature Lamps
Compromises faced: what to specify. 25¢

R56—Buckling of Coil Springs
How to predict. 25¢

R53—Significance of WK^2
Selecting motors for high inertia loads. 25¢

NEEDED: EFFECTIVE VIBRATION ISOLATION AT TEMPERATURE EXTREMES



Vibration-sensitive equipment in high performance missiles and aircraft often poses a two-pronged problem to design engineers: effective isolation against destructive shock and vibration—*at temperature extremes.*

ANSWER: MB'S NEW BROAD TEMPERATURE METAL ISO-DAMP (tm) MOUNT

MB's new broad temperature Iso-Damp mount consists of two load carrying springs, mounted in opposed position, with built-in damper assembly to restrict resonant build-up. It requires no external cooling, can be used at temperatures from −100°F. to +500°F.

WHAT'S YOUR MOUNT PROBLEM?

These new mounts can be adapted easily to the isolation of other special equipment as well. Or, perhaps one of MB's many other mount designs may be the answer to your particular vibration control problem. MB has not only the mounts, but also the experience and personnel to find the right answer for you. Write us for complete information—ask for Bulletin 418-4.

MB ELECTRONICS
A DIVISION OF TEXTRON ELECTRONICS, INC.
1076 State Street, New Haven 11, Conn.

PRECISION BALLS

MATERIALS UNLIMITED

Hartford's leadership in research for better ball materials and higher precision is paying off every day for design engineers. It is paying off in a wider scope of materials, finer finishes and closer tolerances. It can pay off for you. Next time you have a problem that requires precision balls, regardless of the material characteristics required, let Hartford engineers assist you.

New Catalog!

Includes new AFBMA ball standards cross referenced to previous standards. Most complete reference with comprehensive data on balls. Assures quick and easy selection. Your copy will be sent promptly on request.

Specify Hartford PRECISION BALLS • BEARINGS

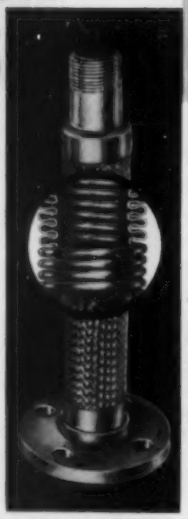
HARTFORD STEEL BALL CO.
41 Jefferson Avenue, West Hartford, Conn.

114 CIRCLE 114 ON READER SERVICE CARD

NEW Allflex VIBRATION TAMERS

IN STAINLESS STEEL, MONEL, BRONZE . . .
. . . CUSTOM ENGINEERED FAST . . . TO

CALM YOUR JITTERY PIPELINES



Write NOW for your copy of the NEW ALLFLEX VIBRA-TAMER DATALOG

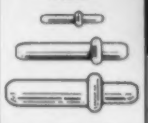
602

ALLIED METAL HOSE CO.
3790 Ninth St., Long Island City 1, N. Y. Phone: STillwell 4-5173

CIRCLE 207 ON READER SERVICE CARD

50% SAVINGS with BEAD CHAIN® Multi-Swage Parts

CONTACT PINS



TERMINALS

JACKS

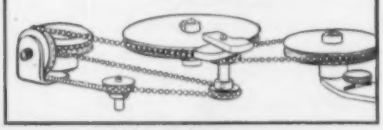
FRICTION CONTACTS

also PRINTED CIRCUIT MINIATURE PARTS

Contact pins, terminals, jacks or any small tubular parts. Maximum ¼" diameter x 1¼" length.
Send sketch for quotations.

BEAD CHAIN DRIVES

Low-speed positive drives or motion transfer . . . at far less cost!



Send for Multi-Swage or Bead Chain Drive Catalogs!

THE BEAD CHAIN MFG. CO.
92 Mountain Grove St., Bridgeport 5, Conn.

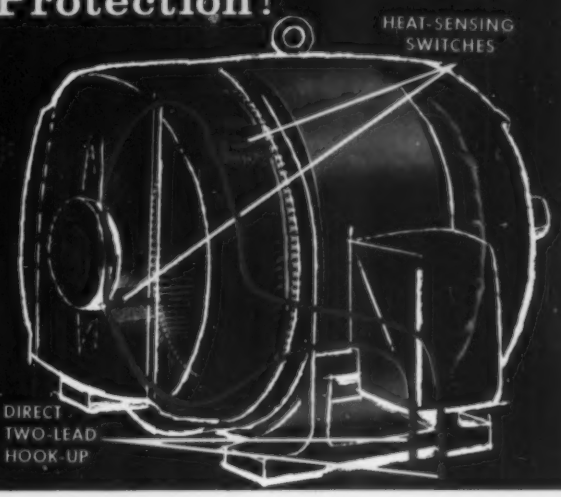
CIRCLE 208 ON READER SERVICE CARD

GENERAL ELECTRIC

New Concept in Motor Protection!

Tri-Clad '55' Thermo-Tector

SYSTEM ENDS OVERLOAD BURNOUT!



General Electric offers a *totally new* type of protection on *all* Tri-Clad '55' motors 7½-125 hp!

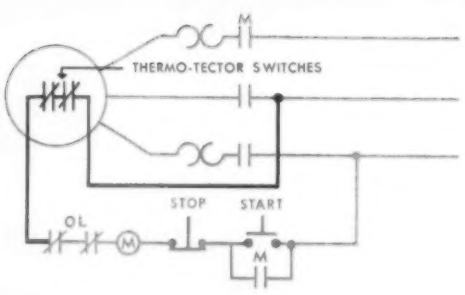
Exclusive THERMO-TECTOR system has heat-sensing switches buried in stator windings. Switches shut off motor *only* when stalls, overloads or other conditions threaten heat damage to motor windings.

Unique THERMO-TECTOR system "anticipation" feature varies motor shut-off point according to rate of winding heat rise. This flexibility allows *maximum motor output* under all conditions.

TURN PAGE FOR FURTHER INFORMATION

NEW Tri-Clad® '55' THERMO-TECTOR SYSTEM

Allows Full Motor Output— No Wasteful "Safety Margin" Needed



Thermo-Tector system needs *no costly amplifying relays*, connects directly to any G-E motor controller.

You get full output from Tri-Clad '55' motors with Thermo-Tector system. Variable response feature of heat-sensing switches allows motor to operate right up to safe limits under any operating condition.

Thermo-Tector switches are offered on *all* Tri-Clad '55' motors in frames 254U-445U. For more information, contact your G-E Apparatus Sales Office or write for Bulletin GEA-7092, Section 866-03, Schenectady 5, N. Y.

SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL ELECTRIC

DESIGN LITERATURE

From Zero to Infinity

CONSTANCE REID. Thomas Y Crowell Co, 432 Park Ave S, NYC. 5 x 8, 161 pp. $3.95.

The reader finds here a lively discussion of one of the most fascinating subjects in the world—the natural numbers. This book, a revision of the original published in 1955, includes a new chapter on infinite sets.

Each digit has a story stretching back into antiquity and a unique "personality." All are interesting. The author tells of different kinds of numbers—prime, square, figurate, perfect, to name a few. She also gives an insight into the absorbing interest the natural numbers held for such great mathematicians as Gauss, Leibnitz, Fermat, and Euler.

Today many ancient problems of these numbers are being attacked and solved with the aid of electronic computors. The author describes the contribution to number theory of the National Bureau of Standards' Western Automatic Computer, one of the fastest computing machines in existence. In 64/1,000,000ths of a second the SWAC can add two figures that run into billions! Computation of the seventeenth perfect number took the SWAC just an hour; it would have taken a man a life-time.

Properties of Elemental and Compound Semiconductors

Edited by HARRY C GATOS. Interscience Publishers Inc, 250 Fifth Avenue, New York 1. 9¼ x 6¼, 340 pp. $8.50.

A series of conference papers given Aug 31 to Sept 2, 1959. Part I: Metallurgical and Chemical Aspects; Part II: Solid State and Surface Reactions; Part III: Chemical and Lattice Defects; Part IV: Physical Properties and Device Applications; Part V: The Role of Dislocations in Device Properties.

Combined Effects of Axial Load, Thermal Stress, and Creep in Flat Plates

HUANG and VAN DER MAAS. (WADC Technical Report 57-442), PB 161087. Dept of Commerce, Washington 25, DC. 8 x 11, 131 pp. $2.75.

Methods presented in this report are for calculating the stresses and strains in unevenly heated flat plates. The methods are limited to the analysis of loadings in the plane of the plate and to temperature and strain distributions which are one-dimensional. The effects of plasticity, creep, and stability have been considered.

Several experiments using 2024-T4 bare aluminum plates are reported in detail. The analytical methods have been verified by the experimental data.

An Introduction to the Mechanics of Solids

CRANDALL and DAHL. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9, 444 pp. $8.50.

The concern of this book is with the mechanics of rigid and deformable solids in equilibrium, with primary emphasis on deformable solids.

Three fundamental physical considerations are stated explicitly: 1) study of forces, 2) study of deformation, and 3) connecting forces to deformation by appropriate force-deformation relations. These steps are introduced by means of a simple case involving springs, where recognition of the forces and the geometry of deformation are uncluttered.

As the treatment develops it becomes more sophisticated. Studying forces involves free-body diagrams, vector algebra, the concept of stress, and the requirements of equilibrium. Studying deformation involves the concepts of displacement and strain, and the requirements of geometric compatibility. The force-deformation relations considered progress from simple spring-constant notions to isotropic elasticity and plasticity and a brief look at nonisotropic elasticity.

Theory of Thermal Stresses

BOLEY and WEINER. John Wiley & Sons Inc, 440 Park Ave South, New York 16. 6 x 9, 586 pp. $15.50.

Here is an account of the presently available theoretical techniques for determination of stresses produced in a solid object when it is subjected to specified heating conditions.

Thermal stress is explained through the basic subjects of thermodynamics, heat-transfer theory, elasticity and inelasticity. A review of heat transfer —together with a discussion of methods of problem formulation and

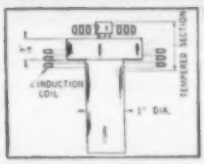
continued on page 119

LepeL

HIGH FREQUENCY INDUCTION HEATING UNITS

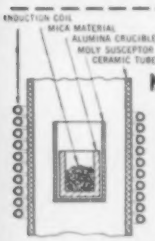
Lepel induction heating equipment represents the most advanced thought in the field of electronics... the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS



Punch Heads Selectively Tempered

Diagram shows arrangement for selectively tempering heads of alloy steel punches. The use of a combination type solenoid and pancake induction coil reduces hardness from Rc 55/56 to Rc 41/44, improving resistance to brittle fracture at the head of the punch. In this case a heating cycle of 55 seconds provides uniform tempering. A multiple position fixture, processing 4 pieces at one time, speeds up production.



Heating Non-Conducting Materials To High Temperatures

Laboratory analyses frequently require heating of non-conducting materials to temperatures of 3,000 to 3,500° F. in vacuum or special atmosphere. This can be accomplished by induction heating with the aid of a metal susceptor. Diagram shows the fusion of mica samples in an alumina crucible, using molybdenum susceptor. A ceramic tube surrounding the susceptor isolates the work for fusion in a vacuum. The molybdenum susceptor is heated by induction, which in turn, heats the crucible by radiation.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw.
Spark Gap Converters from 2 Kw to 30 Kw.

LepeL HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.

So much EXTRA PROTECTION...
So little EXTRA COST...
with HOWELL

WEATHER-SPLASH PROTECTED

For just a few dollars extra... here's mighty important insurance where motors must work dependably *outdoors* in bad weather, or *any place* liquids splash. Only slightly higher-priced than open motors. Low-cost, life-time insurance against high-cost motor damage! A-2913A

- 1-150 hp., a.c.
- All mountings
- Rust-proof hardware
- Guarded openings
- Hexagonal no-slot bolt heads

Write for Bulletin 1010 (A, B)

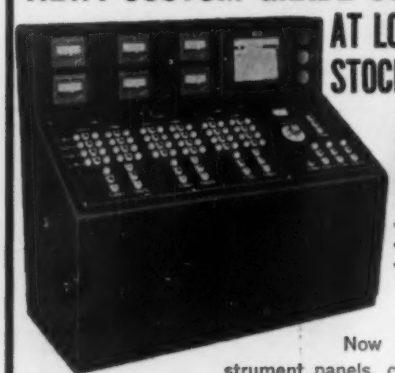
Specify for uses like these:

OUTDOORS	*INDOORS*
Subject to rain, snow, sleet, snakes, rodents, debris...	Subject to hosing, splashing, spraying, dripping...
Air conditioning	Bottling plants
Construction	Breweries
Food processing	Chemicals
Oil Fields	Dairies

HOWELL
electric motors company
Offices in principal cities... see YELLOW PAGES

CIRCLE 209 ON READER SERVICE CARD

NEW! CUSTOM GRADE CONSOLES AT LOW STOCK PRICES!



*GENCO CABINETS & PANELS

* fit your space exactly
* fit your equipment exactly
* protect costly, fragile instruments

Now consoles, instrument panels, cabinets don't have to be either expensive custom installations or cheap stock items. **GENCO** brings you the benefits of each... custom-made at little more than stock prices. Let us quote on your needs.

NEW BRUNSWICK GENERAL SHEET METAL WORKS
425 Cleveland Avenue, Highland Park, New Jersey
.....Rush my copy of new GENCO brochure.
.....Have your representative call.

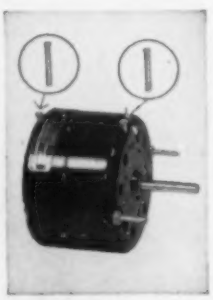
Name.....
Title.....
Company.....
Street.....
City.....Zone.....State.....

IDEAS for cutting costs...

ELIMINATE THREADING OPERATION. Barrel of a small keycase flashlight required separate threading operation to accommodate cap. Fabricated Metal Goods Division engineers suggested three indentations to replace female thread so aluminum barrel could be completely fabricated on our multiple-plunger presses—cutting out cost of second operation.

LOW-COST COLLAR. Toy maker needed a large flat-flange collar to act as stop and contact for switch and to conduct current from batteries to motor operating toy plane. Using experience in making eyelets, our engineers designed a precision aluminum part we could make on a multiple-plunger press. The part simplified assembly, served electrical and mechanical functions—had a very attractive price.

EYELET FOR OIL FEED. Motor manufacturer was making oil-feed tubes by cutting short lengths from seamless tube and flaring one end—and having some trouble in assembly with square-cut end. Our engineers designed a funnel-flange eyelet to the specified dimensions—with a radius on unflanged end to simplify assembly. Because we made the part on a multiple-plunger press, metal gage could be reduced. Total savings were very considerable.



Maybe we can develop cost-cutting ideas for you, too. We offer a complete design-engineering service based on long experience and specialized production equipment. Write for Booklet BG-5. Better yet, send a sample, drawing, or description of a part you need to produce at low cost (any metal, any finish) for an eye-opening quotation. Address: Fabricated Metal Goods Division, The American Brass Company, Waterbury 20-A, Conn. 60178

ANACONDA®
MULTIPLE-PLUNGER PRESS PRODUCTS
Made by The American Brass Company

CIRCLE 118 ON READER SERVICE CARD

CIRCLE 210 ON READER SERVICE CARD

methods of their solution—is included. In addition to the presentation of the theoretical foundations, methods of practical thermal-stress analysis, utilizing strength of materials approximations, are treated in both the elastic and inelastic domains.

Other Books of Interest

Long-term Trends and Problems in the European Steel Industry

United Nations Report. Columbia University Press, 2960 Broadway, New York 27. 8½ x 11, 176 pp. $2.

Machining Characteristics of High-strength Thermal-resistant Materials

PB 161369. Office of Technical Services, Dept of Commerce, Washington DC. 8 x 10½, 415 pp. $6.

Chemical Statistics Handbook

Manufacturing Chemists' Association Inc, 1825 Connecticut Ave NW, Washington 9 DC. 8½ x 11, 519 pp. $3.

ABSTRACTS FROM THE LITERATURE

Overload Protection for Polyphase Motors

Discusses motor construction, overload-control devices and other means of preventing trouble in polyphase motors.

"Closer Overload Protection for Polyphase Motors," Bellinger and Gerg. Allis-Chalmers Electrical Review, Second Quarter '60, Milwaukee 1.

Varying Induction-motor speed

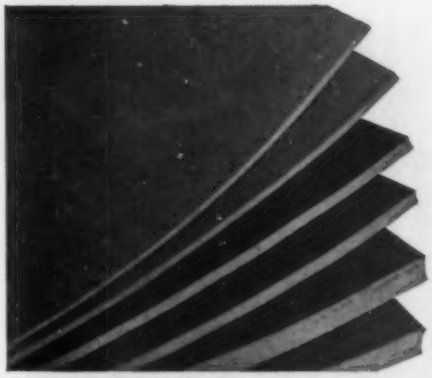
Describes two new ways to vary speed in this type of motor: logmotor and phase mixer motor, both capable of continuous speed variation with variable pole-pitch cylindrical machines.

"Two New Ways to Vary Induction Motor Speed," E. R. Laithwaite, Manchester University (England). Control Engineering, July '60, 330 W 42nd St, New York 36.

Heat-transfer Literature

This guide to significant books and papers on heat-transfer topics covers 1959, includes brief annotations and is organized under the following headings: conduction, channel flow, boundary-layer flow, flow with separated regions, transfer mechanism, natural convection, convection from

continued on page 120



SILICONE SPONGE RUBBER SHEETS

Flexible temperature range -100°F to 500°F

COHRlastic R-10470 silicone sponge rubber sheets have a dense, uniform, non-absorbing closed cell structure highly suitable for soft gasketing, vibration dampening, fairing strips, pads, cushions and other applications where resiliency at extreme temperatures is required. It may be bonded to metals, plastics, fabrics or silicone rubber. COHRlastic R-10470 possesses superior compression set resistance, excellent dielectric properties, immunity to aging, ozone and weather hardening. Meets many specifications.

AVAILABLE FROM STOCK: in 12" x 12" sheets and 24" x 24" sheets — 1/16" through ½". Special thicknesses and sheet sizes up to 30" x 30" and 24" x 48" made to order. Sold nationally through distributors.

FREE SAMPLE and folder — write, phone or use inquiry service.

Leader in Fabrication of Silicone Rubber Products

CHR CONNECTICUT HARD RUBBER CO.

Main office: New Haven 9, Connecticut

CIRCLE 211 ON READER SERVICE CARD

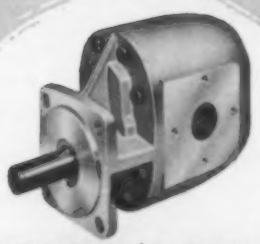
NEW Maximum Performance GEAR PUMP

Speeds to 2800 RPM

Temperatures to 250° F with min. 55 SSU

Pressures to 2250 PSI continuous

Flow rates to 60 GPM



BERRY/DOWTY GPA3 Series

- Designed for operation at mobile equipment engine speeds
- Can be direct-connected, gear driven or belt driven
- Conforms to SAE standards

Berry HYDRAULICS

A DIVISION OF THE OLIVER TYRONE CORPORATION

MAIL FOR COMPLETE DATA

Berry Hydraulics
Corinth 1, Miss.

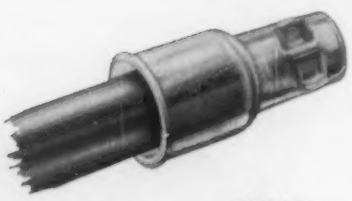
Name_____

Company_____

CIRCLE 119 ON READER SERVICE CARD

DISCERNING DRAFTSMEN THE WORLD OVER DEMAND IMPERIAL THE WORLD'S FINEST TRACING CLOTH

CIRCLE 212 ON READER SERVICE CARD



now . . . the perfect combination for Low Cost Pre-Insulated Splicing

Buchanan "WIDE-RANGE" Pre-Insulated Splice Caps

Just 1 size for 2 #18, 2 or 3 #16, 2 #14, 1 #12 with 1 #14 — or equivalent combinations.

Tough see-thru Nylon. High insulating value. Easy inspection.

Buchanan Ratchet-Controlled tri-SURE-tools

Just 1 size — Hand or Pneumatic. Fast acting — no adjustments — no wire twisting — load either side — splice caps self-positioning.

Exclusive three-indent rolling action crimp provides peak performance — no puncturing of insulation.

UL & CSA approved — 600 V. max. bldg. wire; 1000 V. max. in fixtures — to 105°C. Also UL approved for 1000 V. max. in electric signs.

Write for descriptive bulletin PE-9

BOOTH 438
I. S. A. SHOW
New York—Sept 26-30

BUCHANAN
a subsidiary of
BUCHANAN ELECTRICAL PRODUCTS CORPORATION
HILLSIDE, NEW JERSEY

rotating surfaces, combined heat and mass transfer, change of phase, radiation, liquid metals, low-density heat transfer, measurement techniques, heat-transfer applications.

"A Review of Heat Transfer Literature—1959," Eckert, Hartnett et al. Mechanical Engineering, Aug '60, 29 W 39th St, New York 18.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number of postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 125.

CONVEYORS, CASTERS AND WHEELS—Catalog GC-1, 44 pp. Revised general catalog utilizes more than 150 photos and diagrams to illustrate products, new techniques and applications of materials-handling equipment and systems. Catalog is indexed. Rapids-Standard Co Inc, 342 Rapistan Bldg, Grand Rapids 2, Mich.

Circle 350 on Reader Service Card

AN AND MS FORGINGS—Booklet 90-760, 24 pp. Lists specifications, tolerances and detailed drawings of standard AN and MS forgings made for commercial applications. Harvey Aluminum, 19200 S Western Ave, Torrance, Calif.

Circle 351 on Reader Service Card

CEMENTED CARBIDES—Catalog C-18, 12 pp. Presents design techniques, sizes, properties, hardness, abrasion resistance and other information needed for selection and application of proper grades. Includes charts, graphs and case histories. Carmet Div, Allegheny Ludlum Steel Corp, Ferndale, Detroit 20.

Circle 352 on Reader Service Card

CONTINUOUSLY GENERATED CAMS—Brochure, 5 pp. Explains how continuously generated, mathematically accurate cams can be produced at cost said to be considerably below other less accurate methods. Stelron Cam Co, PO Box 418, Hackensack, NJ.

Circle 353 on Reader Service Card

ELECTRICAL CONDUCTIVITY OF COPPER ALLOYS—Bulletin, 8 pp. Rates electrical conductivity of 56 copper alloys. Also lists available mill shapes for each alloy and typical uses. Bridgeport Brass Co, 30 Grand St, Bridgeport 2, Conn.

Circle 354 on Reader Service Card

LAMINATED PLASTIC ENGRAVING STOCK—Selector-visualizer. Pocket-size folder shows nine colors and patterns stocked for immediate delivery. Charts list finishes, thickness, sheet sizes, proper-

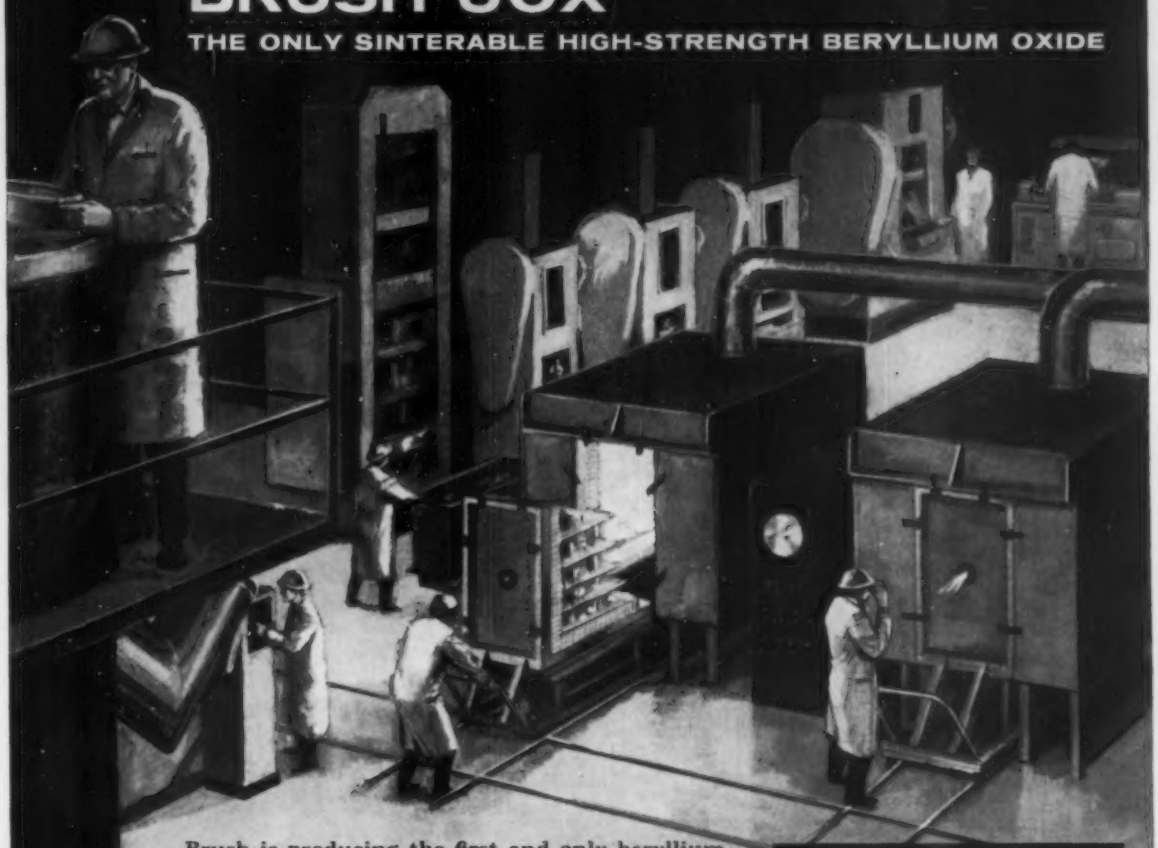
continued on page 123

SIGNIFICANT ADVANCES IN BERYLLIUM TECHNOLOGY COME FIRST FROM BRUSH

A MATERIAL FIRST

BRUSH UOX®

THE ONLY SINTERABLE HIGH-STRENGTH BERYLLIUM OXIDE



Brush is producing the first and only beryllium oxide that is both sinterable and 99.95+% pure. This combination means that manufacturers of nuclear, electronic, and aero/space components can now mass produce ceramics taking full advantage of beryllium oxide's remarkable properties.

BeO is an excellent reflector and moderator of neutrons. Its unique thermal properties include room temperature conductivity superior to most metals. It has good strength, a melting point of 4658° F., and is inert to chemical attack.

More detailed information on versatile UOX® is yours for the asking. Contact us at ENdicott 1-5400 or 5209 Euclid Avenue in Cleveland, Ohio, and we will show you how beryllium oxide can fit into your requirements for high-performance ceramic components.

Any shape that can be fabricated by standard ceramic production methods can be produced in UOX® beryllium oxide.

THE BRUSH BERYLLIUM COMPANY

Wallex Casting on Tail Skid Protects Navy Jet Fighter

When navy jets land on pitching ships, jet tails sometimes hit and scrape the deck. To protect both the aircraft and the deck, McDonnell puts smooth pads on the tail skids of its Demon jet fighter. Cast of wear-resistant Wallex alloy, these pads rebuff impact and corrosion, create little friction to mar flight decks.

Curved Wallex casting brazed to steel plate forms tail skid pad assembly.

As our example above shows, the proper functioning of a whole assembly can often be insured by protecting just one small area from damaging wear. Castings of various Colmonoy alloys are doing just that, in hundreds of places. Colmonoy nickel, cobalt, and iron-base alloys are also applied as welding rod, electrodes, paste, and as Sprayweld Powder. Learn more about this remarkable group of alloys.

Ask for Colmonoy Hard-Facing Manual No. 79.

HARD-SURFACING & BRAZING ALLOYS

WALL COLMONOY CORPORATION
19345 JOHN R STREET • DETROIT 3, MICHIGAN

Buffalo • Chicago • Houston • Los Angeles • Morrisville • New York • Pittsburgh • Montreal • London, England

122 CIRCLE 122 ON READER SERVICE CARD

M-U-L-T-I C S-P-E-E-D

CONSTANT

Constant Torques — *Constant hp*

Variable Torques — *2, 3, 4 speeds*

- ¼—100 hp, a. c.
- 3 or 2 phase
- 2, 3, 4 speeds
- 3600 down to 450 rpm

USES LIKE THESE

- Blowers, fans
- Conveyors
- Elevators
- Machine tools
- Pumps

Write for Bulletins 1005, 1015.

Make you dizzy? Needn't! But . . . you may find a Howell *Multi-Speed* to be just the motor you need.

For years, Howell Multi-Speeds have proved ideal where motors must run at more than one speed, but don't have to provide variations in speed.

Your HOWELL MAN will give you expert application assistance. Call him! A-2314A

HOWELL
electric motors company
Offices in principal cities . . . see YELLOW PAGES

CIRCLE 213 ON READER SERVICE CARD

---

new way to make products better, more efficient...

ACE PRECISION NYLON BALLS

Precision manufactured from DuPont Nylon Resin to close tolerance of ±.001 on diameters and .001 on sphericity, Ace Nylon Balls give design flexibility and production economy. Light in weight... tough at low temperatures... stable at high temperatures... resistant to corroding chemicals such as sulphuric acid, etc.... almost abrasionproof... these mass-produced balls have hundreds of industrial applications. Come in 14 standard sizes from ⅛" to ¾".

Complete facilities for fabrication of plastic parts for all industries. Estimates submitted promptly on receipt of blueprints or specifications.

Write for samples. Bulletin N, price list, TODAY.

EXTRUSION MOLDERS AND FABRICATORS

ACE PLASTIC COMPANY
91-56 Van Wyck Expwy., Jamaica 35, N. Y. JAmaica 3-5500

CIRCLE 214 ON READER SERVICE CARD

ties and fabricating facilities. Formica Corp, 4554 Spring Grove Ave, Cincinnati 32.

Circle 355 on Reader Service Card

SHAFT-MOUNTED GEARED SPEED REDUCERS—Brochure F-2003, 12 pp. Contains description of shaftmounted geared speed reducers and 12 special features are noted on cutaway illustration. Also includes selection and ordering instructions. US Electrical Motors Inc, PO Box 2058 Terminal Annex, Los Angeles 54.

Circle 356 on Reader Service Card

MECHANICAL SHAFT SEALS—Folder, 8 pp. Describes and illustrates two general-purpose mechanical shaft seals for pumps. One type is for use where housing bore is limiting factor; the other is for applications where axial length must be kept to min. With cutaway views and mounting dimensions. Rotary Seal Div, Muskegon Piston Ring Co, Sparta, Mich.

Circle 357 on Reader Service Card

WASHABLE TRACING FILM—Bulletin, 4 pp. Explains how printability of original tracings on drafting film can be restored by washing with soap and water. Includes sample of drafting film and pencil that puts down waterproof plastic line. Keuffel & Esser Co, 3rd and Adams Sts, Hoboken, NJ.

Circle 358 on Reader Service Card

INFRARED COMPONENTS—Catalog 62460, 8 pp. Presents component parts for heating, baking and drying applications and tells how to order and set up infrared system to meet custom requirements. John J Fannon Products Co, 3000 E Woodbridge, Detroit 7.

Circle 359 on Reader Service Card

TELEPHONE-TYPE RELAYS—Folder, 4 pp. Covers characteristics of seven basic relays, as well as coil data and available enclosures. Nomogram upon which operating speed of BS relay can be calculated is included. Potter & Brumfield Div, American Machine & Foundry Co, Princeton, Ind.

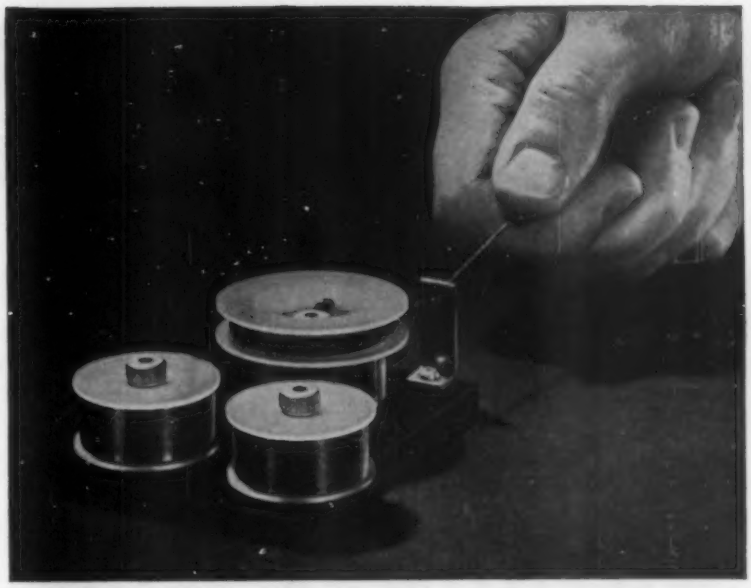
Circle 360 on Reader Service Card

CANNED PUMPS—Bulletin 728.1, 4 pp. Specifications, materials of construction, performance curves and dimensions of sealless pumps, which can be furnished in UL-approved explosionproof construction. Goulds Pumps Inc, 215 Black Brook Rd, Seneca Falls, NY.

Circle 361 on Reader Service Card

VIBRATION ISOLATOR—Bulletin 60-07, 2 pp. Ratings, performance and application information on shock and vibration isolator for avionic equipment. Cutaway

continued on page 125



NEG'ATOR® MOTORS FROM STOCK

for Experimental Designers

As a time-and-cost saving shortcut for design engineers who need a means for applying constant tension forces through long deflections, Hunter now offers six stocked models of constant-torque NEG'ATOR Spring Motors.

Originally developed for use as "idea tools" for experimental design, standard NEG'ATOR Motors have found wide application as product components. For this reason, models carried in stock have been expanded to provide cable-tension ranges from 0.375 lb. through 5.0 lbs., as indicated by the table below.

Orders for stock motors will be shipped immediately. Prices are shown in the table.*

Model No.	Spring Torque in Lb.-In.	Cable Tension in Lbs.	No. Revolutions	Cable Length in In.	Endurance (Min. No. Cycles)	Price
P7172	.1	0.375	20	36	3,000	$5.00
A2025-1	.78	1.0	15	72	7,500	8.00
A2025-2	1.56	2.0	15	72	2,500	8.00
A2025-3	2.33	3.0	15	72	4,500	12.00
A2025-4	3.12	4.0	15	72	2,500	12.00
A2025-5	3.90	5.0	15	72	2,000	12.00

For a good idea on how NEG'ATOR Springs are being applied, ask for Issue 12 of the NEG'ATOR SKETCHBOOK.

P7172 MATERIALS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—aluminum; Cable—Nylon.

MATERIALS, OTHER MODELS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—Black Plastic; Cable—stainless steel, preformed.

**Prices shown are not indicative of the cost of NEG'ATOR Springs when made in quantity, to specifications, for large-volume motor and other applications.*

HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

5 Spring Avenue, Lansdale, Pennsylvania

SPRINGS · STAMPINGS · QUALITY CONTROL EQUIPMENT

choose from
Atlantic India's

thousands of rubber molds and dies

A 40 year accumulation of molds and dies are now on hand at Atlantic India, ready to serve you. Chances are one of our standing molds or dies will fit your needs.

If it happens that your application calls for a unique rubber product we have years of "know-how" at your command. What ever your need, washers, gaskets, molded parts, extrusions, sheet or sponge rubber, Atlantic India is ready to serve you.

SEND TODAY!
Catalog No. 52
158 pgs. showing thousands of diagrams

Atlantic India Rubber Wks., Inc.

Producers of the AIRWIN *line of Rubber Products*

573 West Polk St., Chicago 7, Illinois

insure permanent leakproof joints in copper or brass piping

Fairbanks THREADLESS Valves

"Fairco-Braze" Threadless Valves for silver brazed joints. Cut costs, speed installation of piping systems handling steam, hot or cold water, oil, compressed air, carbon dioxide, Freon and many other liquids and gases.

The silver brazed connection withstands tension, compression, torsion and vibration to a far greater degree than any other type joint.

Solder End Threadless Valves for soldered joints. Get perfect seal of valves for type "K", "L" and "M" copper tubing with Fairbanks Solder End Threadless Valves. Simple, quick installation provides a smooth, compact, full flow assembly that has high resistance to corrosion.

Full line of Fairbanks Solder End Threadless Valves —Globes, Gates and Checks—have an unusually wide application range.

YOURS ON REQUEST: Fairbanks Valves Catalog, complete with cutaways, details, and specifications describing these Fairbanks Threadless Valves.

THE **FAIRBANKS** COMPANY
393 LAFAYETTE STREET NEW YORK 3, N. Y.
BRANCHES:
N. Y. 3 • Boston 10 • Pittsburgh 22 • Rome, Ga.

CIRCLE 215 ON READER SERVICE CARD

• *first of a series*

WHAT YOUR HOWELL MAN

represents and has to offer

This is a brief message to our many friends who have contributed so importantly to our growth.

Our *corporate* and *product* "Images" have changed vastly in the past few years.

Howell now also offers you the combined broad motor lines of: *The Ohio Electric Mfg. Company; Kingston-Conley, Inc.; The Leland Ohio Electric Co.*

Each is a leader in certain important areas. Each is known for certain outstanding products. Each has built on ideas, initiative, integrity.

Consolidation is now completed. *People, Plants, Products* of four formerly separate enterprises are now ONE COMPANY . . . dedicated to continued high standards of service to American Industry.

A few words about our:

products

Howell and its subsidiaries make: MOTORS—1/40 —300 hp, a.c.; GEARED DRIVES—gearmotors and coupled units, *down to 1.2 rpm;* GENERATORS—.3 to 15 KW.

Chances are, we have what you want. If not, *we'll make it.*

A-2920A

HOWELL *electric motors company*
SUBSIDIARIES:
OHIO ELECTRIC MFG. COMPANY • LELAND OHIO ELECTRIC COMPANY • KINGSTON-CONLEY, INC.

CIRCLE 216 ON READER SERVICE CARD

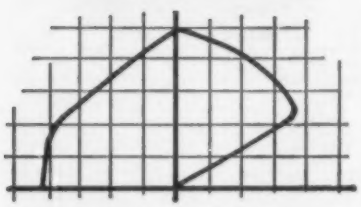
Newest Addition to

STEWARD'S MAGNET FAMILY

High Energy Product

F-500

ORIENTED CERAMIC PERMANENT MAGNET



BH=3.5 x 10^6 G.Oe
Hc=2000 Oe Br=3900 G

APPLICATIONS:

LOUDSPEAKER MAGNETS MAGNETIC SEPARATORS AND OTHERS REQUIRING HIGH BH PRODUCT AND COERCIVITY

Look to D. M. Steward Manufacturing Company for all of your Ceramic Magnet requirements.

Write for F-500 brochure to:

D. M. STEWARD MFG. CO.
3640 JERROME AVENUE
CHATTANOOGA, TENNESSEE

CIRCLE 217 ON READER SERVICE CARD

DESIGN LITERATURE.....continued

illustration shows construction. Barry Controls Inc, 700 Pleasant St, Watertown 72, Mass.

Circle 362 on Reader Service Card

EDGEGRAPHING – Technical data sheets, 16 pp. Discusses technique for hand analysis of complex engineering information in 10, 20 or more variables. Statistical Engineering Institute, 8 Fuller Rd, Wellesley Hills 81, Mass.

Circle 363 on Reader Service Card

MEDIUM VOLTAGE DC POWER SUPPLIES–Bulletin 204A, 2 pp. Describes rack and bench models of power supplies with output range of 0 to 125 v dc. Opad Electric Co, 43 Walker St, New York 13.

Circle 364 on Reader Service Card

LETTERHEAD REQUESTS ONLY

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

ELECTRIC MOTORS–Condensed motor-data and price bulletin 150, 14 pp. Gives construction, dimensions and price information on fhp and integral-hp motors, as well as modifications available. Especially geared to OEM users who require special motor designs. Doerr Electric Corp, 100 N 4th Ave, Cedarburg, Wis.

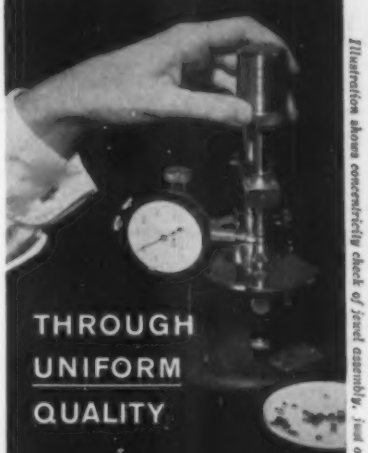
LAMINATED PLASTICS – 1961 Designer's Fact Book, 115 pp. Contains property and application information covering 70 standard, special and molding grades of high-pressure, thermosetting laminating plastics, military specifications, a grade-comparator chart, tolerance and weight specifications. Available to research and production engineers, designers and purchasing agents. Formica Corp, 4550 Spring Grove Ave, Cincinnati 32.

"That's just not my opinion, it's yours too."

Bird

JEWEL BEARINGS

CUT YOUR COSTS



THROUGH UNIFORM QUALITY

Illustration shows concentricity check of jewel assembly, just one of several important quality control steps.

• Exacting quality control standards employed by Bird are your guarantee that every Bird Sapphire or Glass Jewel Bearing, or Complete Jewel Assembly or Cushion Jewel Assembly, is as specified. There's never a chance of inconsistency in dimensions, chemical and physical properties.

As an added benefit, Bird Complete Assemblies cut your manufacturing costs because they reach you ready for immediate installation . . . eliminating all problems with expensive rejects and breakage.

Our engineering staff would be pleased to work with you on your special jewel bearing needs. Write for our free catalog with complete details on properties and uses of jewel bearings.

Richard H. Bird & CO. INC.
1 SPRUCE ST., WALTHAM, MASS.

serving industry with fine jewels since 1913

CIRCLE 125 ON READER SERVICE CARD

EMPLOYMENT OPPORTUNITIES

DISPLAYED RATE

The advertising rate is $37.00 per inch for all advertising appearing on other than contract basis. Frequency rates quoted on request.

UNDISPLAYED RATE

$2.10 per line, minimum 3 lines. Position Wanted ads in this style ½ the above rate. To figure advance payment count 5 average words to a line.

WANTED

CREATIVE DESIGN ENGINEERS

(M.E.'s, E.E.'s, etc.)

Managerial and staff positions available for individuals combining experience, training, or motivation in industrial design (Imaginative, inventive, artistic approach to function, form, cost, marketability) plus product R&D engineering. Send resumes in strict confidence.

THEODORE S. JONES & CO.
(Specialists in Design Placement)
Box 41Z Milton 87, Mass. Tel. OX-6-3221

PRODUCT ENGINEER

$15,000 PER YEAR

Degree in Electrical Engineering and Supervisory Experience. Man 25-35 to handle Design, Development, Test and Application of Aircraft Quality Motors. Company client assumes all employment expenses.

ESQUIRE PERSONNEL SERVICE, Inc.
202 South State St., Chicago 4, Illinois
Phone Harrison 7-6337

ARTICLE REPRINTS

In addition to the recent titles added to our reprint list, shown on page 118, the following earlier titles are still available.

R47—FASTENING GEARS TO SHAFTS
Roundup of 15 practical methods..25¢

R45—COMBINED LOADS ON BEAMS
Faster method of stress analysis...25¢

R41—DESIGN BY DIGITAL COMPUTER
How to choose and use desk-size..50¢

R40—DESIGNING 4-BAR LINKAGES
Methods for straight-line motion...25¢

R38—DESIGN OF CIRCULAR-ARC CAMS
Math avoids graphical methods....25¢

R36—NON-CIRCULAR GEARS
Design guide for practical types...25¢

R33—WET-CELL BATTERIES FOR POWER
Five common types appraised.....25¢

R30—DIMENSIONAL ANALYSIS IN 10 STEPS
New procedure for a classical method 25¢

Each article is reprinted in full with all original charts, tables and data. Send order with remittance to

Reader Service Dept.

PRODUCT ENGINEERING
330 W. 42nd St. New York 36

INDEX OF PRODUCTS

ADVERTISED IN THIS ISSUE

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD

A

Adhesives 26
Air Motors (see Motors, Air)
Aluminum Alloys 30-31, 49, 98

B

Balls 114
Bearing Materials 106
Bearings
  Ball 11
  Jewel 125
  Miniature 11
  Oilless .....3rd Cover
  Roller 54
  Self-Lubricating 109
  Sleeve .....3rd Cover
Beryllium 121
Bi-Metal 29, 107

C

Cabinets 118
Castings 13, 92
Ceramics 125
Chains
  Bead 114
Clutches
  Mechanical 44-45, 103
Compressors 100
Connectors
  Hose 62
  Tube 62
Controllers 111
Control Panels & Switchboards....97, 118
Controls
  Electrical 97
Couplings
  Mechanical 44-45
Cylinders
  Hydraulic 61, 95
  Pneumatic 61, 95

D

Deep Drawing 112
Dies 10
Drafting
  Supplies 28

E

Engineering Services (see also Production Services) 62, 102
Extrusions
  Metallic 30-31

F

Fastening Methods .....4th Cover
Flexible Shafts 5

G

Gaskets 7
Gears 104

H

Hard Surfacing 122
Heating Units 32, 117

I

Instruments
  Mechanical 112

J

Jewels 125
Joints
  Universal 127

L

Laminated Plastics (see Plastics, Laminated)

M

Magnets 125
Metal Fabricated 118
Moldings
  Plastics (see Plastic Parts)
  Powdered Metal (see Powdered Metal Parts)
  Rubber (see Rubber Parts)
Motors, A-C
  Fractional 36-38, 112, 115-116 118, 122, 124
  Integral 112, 118, 122, 124
Motors, Air 61, 100
Motors, D-C
  Fractional 112, 118, 122, 124
  Integral 36-38, 112, 118, 122, 124
Motors, Hydraulic 101

P

Plastic Parts 53, 102, 110, 122
Plastics ..33-34, 50-51, 53, 55-56, 93, 110
Plastics Fabricated 122
Plastics Laminated to Metal..... 93
Powdered Metal Parts.....3rd Cover, 96
Production Machines & Processes.... 123
Production Services (see also Engineering Services) 62, 102
Pumps
  Air 100
  Liquid 119
  Vacuum 100

R

Relays 18-19
Reproduction Supplies 28
Resins 33-34, 55-56
Rivets .....4th Cover
Rolls 22-23
Rubber Parts 124

S

Seals 86
Sheet Fabricated 102
Sheets
  Plastic 119
Silicone Rubber 119
Silicones 2
Speed Increasers & Reducers.....46-47
Spinning 112
Springs 94, 123
Stampings 10, 94, 112
Steel
  Alloy 39-43, 52, 105
  Coated 57-60
  Carbon 35, 39-43
  Stainless 35, 39-43, 52, 105
  Tool 52
Strip, Metallic 57-60
Switches 64, 97

T

Thermostats 111
Timers 108
Torque Converters (see Couplings)
Tracing Cloth 120
Transmissions 99
Tubing
  Flexible Metal 62

V

Valves
  Air .....2nd Cover, 27, 124
  Hydraulic 27
  Solenoid .....2nd Cover, 14, 48
Vibration Dampers
  Mechanical 88, 114
Vibration Mountings 113

W

Weldments 98
Wiring Devices 120

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibilities for errors or omissions

Ace Plastics Co. 122
Allied Metal Hose Co. 114
Aluminum Co. of America 30-31, 98
Anaconda Co., Fabricated Metal Goods Div. 118
Anaconda Metal Hose Co. 62
Armstrong Cork Co. 7
Associated Spring Corp. 94
Atlantic India Rubber Works, Inc. 124

Bead Chain Mfg. Co., Inc. 114
Bellows-Valvair Divs., International Basic Economy Corp. 27
Berry Hydraulics Div., Oliver Tyrone Corp. 119
Bird Co., Inc., Richard H. 125
Blaw-Knox Co. 13
Bound Brook Oil-Less Bearing Co. ..... 3rd Cover
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc. 54
Brush Beryllium Co. 121
Buchanan Electrical Products Corp. 120

Carpenter Steel Co. 105
Chace Co., W. M. 29
Cincinnati Gear Co. 104
Clare & Co., C. P. 64
Commercial Shearing & Stamping Co. 101
Connecticut Hard Rubber Co. 119
Consolidated Molded Products Corp. . 110
Crane Packing Co. 106
Curtis Universal Joint Co., Inc. 127
Cutler-Hammer, Inc. 18-19

Dodge Mfg. Corp. 46-47
Dow Corning Corp. 2
du Pont de Nemours & Co., (Inc.), E. I., Polychemicals Dept. 33-34, 55-56

Fairbanks Co. 124
Fairmont Aluminum Co., Subs. of Cerro de Pasco Corp. 10
Fastex Div., Illinois Tool Works 4th Cover
Fenwal, Inc. 111
Firestone Tire & Rubber Co., Industrial Products Div. 88
Formsprag Co. 44-45

Garlock, Inc. 109
Gast Mfg. Corp. 100
General Electric Co., Apparatus Dept. 36-38, 97, 115-116

Halex Corp., Subs. of Polymer Corp. 96
Hamilton Foundry, Inc. 92
Hannifin Co., Parker-Hannifin Corp. 61
Hartford Steel Ball Co. 114
Howell Electric Motors Co. 112, 118, 122, 124
Hunter Spring Co. 123

Illinois Tool Works, Fastex Div. 4th Cover
Imperial Tracing Cloth 120

Lepel High Frequency Laboratories, Inc. 117

McLouth Steel Corp. 35
MB Electronics Div., Textron Electronics, Inc. 113
Marsh Instrument Co., Div. of Colorado Oil & Gas Corp. 112
Masland Duraleather Co., The 93
Miniature Precision Bearings, Inc. 11
Minneapolis-Honeywell Regulator Co., Industrial Div. 48

New Brunswick General Sheet Metal Works 118

Parker Seal Co., Div., Parker-Hannifin Corp. 86
Pittsburgh Steel Co., Thomas Strip Div. 57-60
Plastic & Rubber Products Co., Fluorocarbon Div. 53
Post Co., Frederick 28

Reynolds Metals Co., Industrial Products Div. 49
Rhodes, Inc., M. H. 108
Rockwell-Standard Corp., Transmission & Axle Div. 99
Ross Operating Valve Co. ..... 2nd Cover
Rubber & Asbestos Corp. 26

Spincraft, Inc. 112
Steward Mfg. Co., D. M. 125
Stolper Industries, Inc. 102

Texas Instruments Incorporated Metals & Controls Division 107
Tomkins-Johnson Co. 95
Twin Disc Clutch Co. 103

Union Carbide Plastics Co., Div., Union Carbide Corp. 50-51
United States Steel Corp. 22-23, 39-43

Valcor Engineering Corp. 14
Vulcan Electric Co. 32

WaiMet Alloys Co. 52
Wall Colmonoy Corp. 122
White Industrial Div., S. S. 5

LLOYD R. LAWRENCE *advertising sales manager*
P. F. PRITCHARD *manager, market development*
THOMAS R. COASH *circulation*
RUSSELL T DOUGLAS *business manager*

ADVERTISING SALES STAFF

ATLANTA 3 . . . Ray K. Burnet, 1301 Rhodes-Haverty Bldg, Jackson 4-6951

BOSTON 16 . . . M. A. Williamson, Jr., 350 Park Square Bldg, Hubbard 2-7160

CHICAGO 11 . . . Mid-Western Adv Sales Manager, A. E. Meanor; R. W. Bruley, L. Anderson, 520 N Michigan Ave, Mohawk 4-5800

CLEVELAND 13 . . . A. F. Tischer, 1164 Illuminating Bldg, 55 Public Sq, Superior 1-7000

DALLAS 1 . . . John Grant, 901 Vaughn Bldg, 1712 Commerce St, Riverside 7-5117

DENVER 2 . . . John W. Patten, Tower Bldg, 1700 Broadway, Alpine 5-2981

DETROIT 26 . . . P. B. Robinson, 856 Penobscot Bldg, Woodward 2-1793

HOUSTON 25 . . . Gene Holland, W-724 Prudential Bldg, Jackson 6-1281

LOS ANGELES 16 . . . Robert Obenaur, 1125 West 6th St, Huntley 2-5450

NEW YORK 36 . . . B. K. Adams, F. J. McKinley, 500 Fifth Ave, Oxford 5-5959

PHILADELPHIA 3 . . . John B. Lewis, 6 Penn Center Plaza, Locust 8-4330

PITTSBURGH 22 . . . C. F. Leveroni, 4 Gateway Center, Express 1-1314

ST LOUIS 8 . . . R. W. Bruley, 3615 Olive St, Continental Bldg, Jefferson 5-4867

SAN FRANCISCO 4 . . . W. C. Woolston, 68 Post St, Douglas 2-4600.

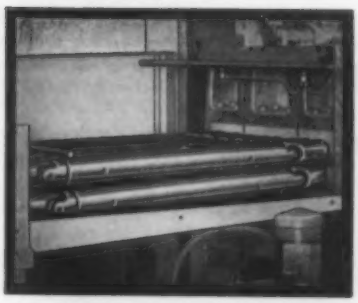
SUBSCRIPTIONS. Send subscription correspondence and change of address to Fulfillment Manager, PRODUCT ENGINEERING, 330 W 42nd St, New York 36, NY. Subscribers should notify Fulfillment Manager promptly of any change of address including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders.

OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. E. Venezian, Vice President and Circulation Coordinator. **OFFICERS OF THE CORPORATION:** Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cocke, Secretary.

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.
EMPLOYMENT OPPORTUNITIES 126

Index to Advertisers appears on P. 127
Products Index appears on P. 126

HOW CURTIS SOLVED A CLOSE CENTER-TO-CENTER PROBLEM

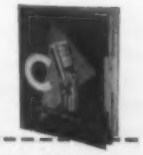


The close center-to-center spacing of these drive spindles on a Sutton-Maust Precision Backed-up Roller Leveler created a tough problem for its manufacturer. He needed a universal joint strong enough to stand up under heavy rolling mill conditions, yet small enough to operate at such close quarters.

The answer was a Curtis universal joint! The maximum load carrying capacity and minimum torsional deflection of the Curtis joint was found to be completely satisfactory. And Curtis' famous Telltale Lock Ring construction permits quick disassembly for easier maintenance.

This is just one of the many power transmission problems solved by Curtis universal joints — size for size the *strongest* universal joints designed for industry. Selected materials, precision engineering, and 40 years' experience manufacturing universal joints exclusively make them that way.

WRITE FOR THE NEW CURTIS CATALOG, JUST PUBLISHED



14 sizes always in stock 3/8" to 4" O.D.

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.
119 Birnie Ave., Springfield, Mass.
As near to you as your telephone

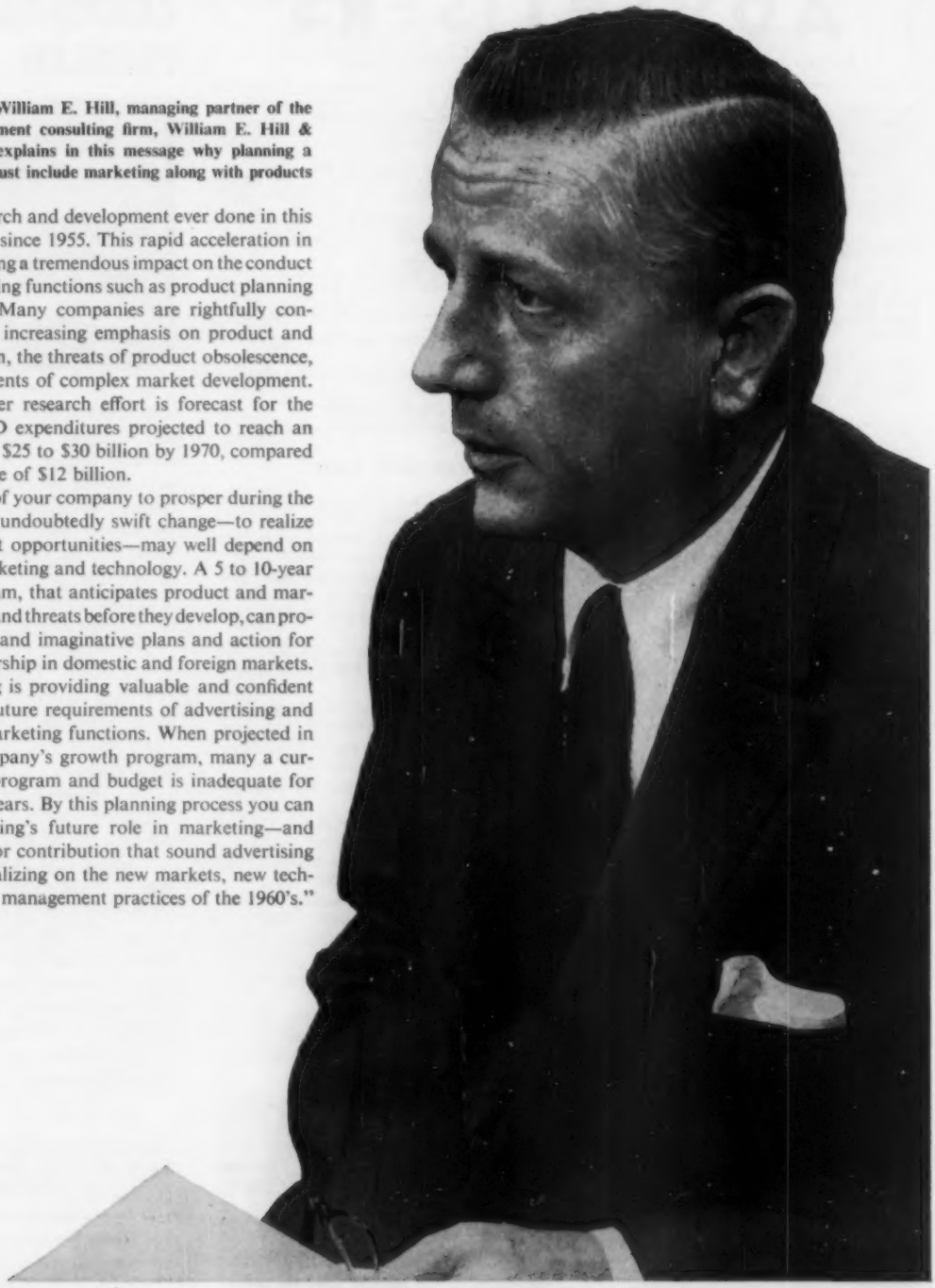
"Long-range planning for advertising?"

"Certainly," says William E. Hill, managing partner of the New York management consulting firm, William E. Hill & Company, and he explains in this message why planning a company's future must include marketing along with products and processes.

"Half the research and development ever done in this country has been since 1955. This rapid acceleration in technology is having a tremendous impact on the conduct of specific marketing functions such as product planning and advertising. Many companies are rightfully concerned about the increasing emphasis on product and process innovation, the threats of product obsolescence, and the requirements of complex market development. And still a greater research effort is forecast for the 1960's, with R&D expenditures projected to reach an estimated level of $25 to $30 billion by 1970, compared with a present rate of $12 billion.

"The capacity of your company to prosper during the next ten years of undoubtedly swift change—to realize the period's profit opportunities—may well depend on your creative marketing and technology. A 5 to 10-year long-range program, that anticipates product and market opportunities and threats before they develop, can provide the advance and imaginative plans and action for competitive leadership in domestic and foreign markets.

"Such planning is providing valuable and confident insight into the future requirements of advertising and its companion marketing functions. When projected in relation to a company's growth program, many a current advertising program and budget is inadequate for the next 5 to 10 years. By this planning process you can optimize advertising's future role in marketing—and establish the major contribution that sound advertising can play in capitalizing on the new markets, new technologies and new management practices of the 1960's."



AIA

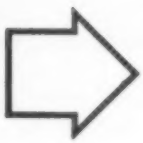
ASSOCIATION OF INDUSTRIAL ADVERTISERS

271 madison avenue • new york 16, n. y. • telephone murray hill 5-8921

An organization of over 4000 members engaged in the advertising and marketing of industrial products, with local chapters in ALBANY, BALTIMORE, BOSTON, BUFFALO, CHICAGO, CLEVELAND, COLUMBUS, DALLAS, DENVER, DETROIT, HAMILTON, ONT., HARTFORD, HOUSTON, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, MINNEAPOLIS, MONTREAL, QUE., NEWARK, NEW YORK, PHILADELPHIA, PHOENIX, PITTSBURGH, PORTLAND, ROCHESTER, ST. LOUIS, SAN FRANCISCO, TORONTO, ONT., TULSA, YOUNGSTOWN.

PERSONAL READER SERVICE

USE ATTACHED CARDS FOR PERSONAL COPIES OF ADDITIONAL PRODUCT DESIGN DATA



. . . Data on Materials and Components
. . . Free Article Reprints
. . . New Catalogs and Bulletins
. . . Brochures on Advertised Products
. . . Personal Suscriptions to PRODUCT ENGINEERING

Valuable new data on product design engineering — readily available to you — FREE.

Just circle the numbers on the request cards that are identical with the numbers printed under each Advertisement, New Product and Bulletin throughout this issue.

Reprint numbers are prefaced with the letter "P". *One free reprint* is available for each article offered.

Issue of September 19, 1960
PRODUCT ENGINEERING
Card Expires November 18, 1960

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING
330 WEST 42nd STREET
NEW YORK 36, N. Y.

22 FL

USE THIS CARD

to be sure that you get your personal copy of the new Design Digest issue just off the press.

This comes as part of every regular subscription (U.S.A.) at $3.00 per year.

This single popular issue contains more than 600 pages of basic design information . . . organized and indexed for ready reference.

Issue of September 19, 1960
PRODUCT ENGINEERING

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING
330 WEST 42nd STREET
NEW YORK 36, N. Y.

22 FL

ADD TO YOUR DESIGN REFERENCE FILE FROM

EDITORIAL REPRINTS AVAILABLE

(Single reprints free)

P38—STATISTICAL TOLERANCES
"Natural" limits permit wider tolerances; table predicts misfits.

P40—ELLIPTICAL GEARS
For cyclic speed variations; useful design equations, examples.

P41—WHEN TO USE PRINTED WIRING
When to stay with conventional wiring for industrial service.

P45—3-D HARNESS WIRING
For complex circuits; how it's done with punch cards and camera.

P46—INTEGRAL BALL BEARINGS
New approach to product improvement, longer bearing life or higher loads.

P49—ANALOG FOR HEAT FLOW
Electrical simulator predicts heat flow under complex conditions.

P50—WEAR OF ROLLING SURFACES
New equations give life expectancy for gears, cams, bearings.

P51—PNEUMATICS SIMULATES ELECTRONICS
Dimensional analysis of all units needed in control service.

P52—SELECTING SOLENOIDS
A guide to ac or dc, and linear or rotary types.

P53—LIGHT-DUTY BELT DRIVES
Performance compared for all five basic types.

P54—EPICYCLIC GEAR SYSTEMS
Modified equations give volume, power capacity, speed ratios, stresses.

P55—DIGITAL STORAGE DEVICES
Evaluation of all available types; where each one performs best.

P56—TAPERED CANTILEVER BEAMS
How to calculate stresses and deflections for five sections.

P57—MOLDED PLASTIC CAMS
When they are preferable to steel cams individually machined.

P58—STRONG ALUMINUM ALLOYS
How the new X2020 stacks up with other high-strength alloys.

P59—THE RESPONSE EQUATION
Some graphical tricks that eliminate tedious slide rule work.

P60—ACCELEROMETER
Evaluation of all types suitable for control applications.

P61—DIMENSIONAL STABILITY IN PRECISE PARTS
How properties change under stress and heat.

(please print or type)

Name ..... Title .....

Street .....

City ..... Zone ..... State .....

Company ..... Major Product Manufactured .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

*MULTIPLE Key No.	PRODUCT ADS Specific Product

REPRINTS

P38	P40	P41	P45	P46	P49	P50	P51	P52
P53	P54	P55	P56	P57	P58	P59	P60	P61

TAKE ADVANTAGE OF NEW LOW PRICE!

Have your own personal subscription to PRODUCT ENGINEERING sent each week to your office or home. You are then sure that you won't miss a single weekly issue. Further, each year of your subscription you will have your copy of the annual, thick Design Digest issue to read and refer to for years to come.

☐ 1 year—NOW $3 U.S. only* ☐ 2 years—NOW $4

*Canada
1 year—$5
2 years—$8

☐ Payment enclosed

☐ Bill me

Name ..... Title .....

Home ☐ .....

Address Office ☐ ..... Dept .....

City ..... Zone ..... State .....

Company Name ..... Product Mfgd .....

NEW CATALOGS AND BULLETINS

GENERAL ENGINEERING

358—Washable Tracing Film, 4 pp, Keuffel & Esser Co.

RESEARCH AND TEST EQUIPMENT

363—Edgegraphing, 16 pp, Statistical Engineering Institute

METALS AND ALLOYS

352—Cemented Carbides, 12 pp, Allegheny Ludlum Steel Corp., Carmet Div.

354—Electrical Conductivity of Copper Alloys, 8 pp, Bridgeport Brass Co.

NON-METALLIC MATERIALS, FINISHES

355—Laminated Plastic Engraving Stock, selector-visualizer, Formica Corp.

FABRICATION PROCESSES AND PRODUCTION

351—An and Ms Forgings, 24 pp, Harvey Aluminum

353—Continuously Generated Cams, 5 pp, Stelron Cam Co.

POWER TRANSMISSION

356—Shaftmounted Geared Speed Reducers, 12 pp, US Electrical Motors Inc.

THIS WEALTH OF VITAL INFORMATION . . .

NEW COMPONENTS

GENERAL ENGINEERING

333—Dry-process Duplicator
335—Drawing Triangle
336—Diffusion-transfer Negative

RESEARCH AND TEST EQUIPMENT

337—Shock-testing Machine
334—Split-dial Push-pull Gage
338—Nylon Thrust Washer Kit

NON-METALLIC MATERIALS, FINISHES

319—Custom Plastic Extrusions

FABRICATION PROCESSES AND PRODUCTION

319—Custom Plastic Extrusions
322—Stock Knobs Are Molded

POWER TRANSMISSION

307—Electromagnetic Clutch-hub
310—Turret Indexing-machine Chassis
318—Midget Shoe-type Brake
324—Stainless, Low-torque Retainer
331—Spring-set, Solenoid Relaxed Brake for 40 Frame Motors

MECHANICAL PARTS

305—Self-conforming Polymer Seal
312—Cellular-sponge Sealing Grommet
322—Stock Knobs Are Molded
323—Pressure-sensitive Nameplates
324—Stainless, Low-torque Retainer
325—Multipurpose Indexing Conveyor
329—15-in.-dia Rotary Table
332—Tread-lock Brake

FASTENING AND JOINING

302—Self-locking Capscrew
303—Adjustable-diameter Bolts
317—Continuous-threaded Studs

MOTORS, ENGINES AND CONTROLS

304—Bidirectional Stepping Motor
309—Static Adjustable-speed Drive
310—Turret Indexing-machine Chassis
320—Fan-cooled Induction Motor

ELECTRICAL, ELECTRONIC COMPONENTS

300—Ultrasonic Sensing and Switching System
301—Modular Rotary Switches
311—Single-circuit Contact Block
313—Decade Tubes Count
314—Lighted Pushbutton Switch
316—Silicon Tunnel Diodes
326—Connector for Terminal Strips
327—Low-cost Power Relay
328—Magnetic Reed Switch
330—Digital Counters and Timers

HYDRAULIC, PNEUMATIC EQUIPMENT

305—Self-conforming Polymer Seal
306—Six Industrial Valves
308—Automatic Seal Rotary Union
315—Miniature Relief Valve
321—Ultrahigh Vacuum Couplings

MECHANICAL PARTS

350—Conveyors, Casters and Wheels, 44 pp, Rapids-Standard Co Inc.
353—Continuously Generated Cams, 5 pp, Stelron Cam Co.
357—Mechanical Shaft Seals, 8 pp, Muskegon Piston Ring Co, Rotary Seal Div.
362—Vibration Isolator, 2 pp, Barry Controls Inc.

ELECTRICAL, ELECTRONIC COMPONENTS

359—Infrared Components, 8 pp, John J Fannon Products Co.
360—Telephone Type Relays, 4 pp, American Machine & Foundry Co.
364—Medium Voltage Dc Power Supplies, 2 pp, Opad Electric Co.

HYDRAULIC, PNEUMATIC EQUIPMENT

361—Canned Pumps, 4 pp, Goulds Pumps Inc.

(please print or type)

Name.....Title.....
Street.....
City.....Zone.....State.....
Company.....Major Product Manufactured.....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS
P38 P40 P41 P45 P46 P49 P50 P51 P52
P53 P54 P55 P56 P57 P58 P59 P60 P61

*MULTIPLE PRODUCT ADS	
Key No.	Specific Product

(please print or type)

Name.....Title.....
Street.....
City.....Zone.....State.....
Company.....Major Product Manufactured.....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS
P38 P40 P41 P45 P46 P49 P50 P51 P52
P53 P54 P55 P56 P57 P58 P59 P60 P61

*MULTIPLE PRODUCT ADS	
Key No.	Specific Product

ADD TO YOUR DESIGN REFERENCE FILE FROM

EDITORIAL REPRINTS AVAILABLE

(Single reprints free)

P38—STATISTICAL TOLERANCES
"Natural" limits permit wider tolerances; table predicts misfits.

P40—ELLIPTICAL GEARS
For cyclic speed variations; useful design equations, examples.

P41—WHEN TO USE PRINTED WIRING
When to stay with conventional wiring for industrial service.

P45—3-D HARNESS WIRING
For complex circuits; how it's done with punch cards and camera.

P46—INTEGRAL BALL BEARINGS
New approach to product improvement, longer bearing life or higher loads.

P49—ANALOG FOR HEAT FLOW
Electrical simulator predicts heat flow under complex conditions.

P50—WEAR OF ROLLING SURFACES
New equations give life expectancy for gears, cams, bearings.

P51—PNEUMATICS SIMULATES ELECTRONICS
Dimensional analysis of all units needed in control service.

P52—SELECTING SOLENOIDS
A guide to ac or dc, and linear or rotary types.

P53—LIGHT-DUTY BELT DRIVES
Performance compared for all five basic types.

P54—EPICYCLIC GEAR SYSTEMS
Modified equations give volume, power capacity, speed ratios, stresses.

P55—DIGITAL STORAGE DEVICES
Evaluation of all available types; where each one performs best.

P56—TAPERED CANTILEVER BEAMS
How to calculate stresses and deflections for five sections.

P57—MOLDED PLASTIC CAMS
When they are preferable to steel cams individually machined.

P58—STRONG ALUMINUM ALLOYS
How the new X2020 stacks up with other high-strength alloys.

P59—THE RESPONSE EQUATION
Some graphical tricks that eliminate tedious slide rule work.

P60—ACCELEROMETER
Evaluation of all types suitable for control applications.

P61—DIMENSIONAL STABILITY IN PRECISE PARTS
How properties change under stress and heat.

(please print or type)

Name ..... Title .....

Street .....

City ..... Zone ..... State .....

Company ..... Major Product Manufactured .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

*MULTIPLE Key No.	PRODUCT ADS Specific Product

REPRINTS
P38 P40 P41 P45 P46 P49 P50 P51 P52
P53 P54 P55 P56 P57 P58 P59 P60 P61

TAKE ADVANTAGE OF NEW LOW PRICE!

Have your own personal subscription to PRODUCT ENGINEERING sent each week to your office or home. You are then sure that you won't miss a single weekly issue. Further, each year of your subscription you will have your copy of the annual, thick Design Digest issue to read and refer to for years to come.

☐ 1 year—NOW $3 U.S. only* ☐ 2 years—NOW $4

*Canada
1 year—$5
2 years—$8

☐ Payment enclosed

☐ Bill me

Name ..... Title .....

Home ☐ .....

Address Office ☐ ..... Dept .....

City ..... Zone ..... State .....

Company Name ..... Product Mfgd .....

NEW CATALOGS AND BULLETINS

GENERAL ENGINEERING

358—Washable Tracing Film, 4 pp, Keuffel & Esser Co.

RESEARCH AND TEST EQUIPMENT

363—Edgegraphing, 16 pp, Statistical Engineering Institute

METALS AND ALLOYS

352—Cemented Carbides, 12 pp, Allegheny Ludlum Steel Corp., Carmet Div.

354—Electrical Conductivity of Copper Alloys, 8 pp, Bridgeport Brass Co.

NON-METALLIC MATERIALS, FINISHES

355—Laminated Plastic Engraving Stock, selector-visualizer, Formica Corp.

FABRICATION PROCESSES AND PRODUCTION

351—An and Ms Forgings, 24 pp, Harvey Aluminum

353—Continuously Generated Cams, 5 pp, Stelron Cam Co.

POWER TRANSMISSION

356—Shaftmounted Geared Speed Reducers, 12 pp, US Electrical Motors Inc.

THIS WEALTH OF VITAL INFORMATION . . .

NEW COMPONENTS

GENERAL ENGINEERING

333—Dry-process Duplicator
335—Drawing Triangle
336—Diffusion-transfer Negative

RESEARCH AND TEST EQUIPMENT

337—Shock-testing Machine
334—Split-dial Push-pull Gage
338—Nylon Thrust Washer Kit

NON-METALLIC MATERIALS, FINISHES

319—Custom Plastic Extrusions

FABRICATION PROCESSES AND PRODUCTION

319—Custom Plastic Extrusions
322—Stock Knobs Are Molded

POWER TRANSMISSION

307—Electromagnetic Clutch-hub
310—Turret Indexing-machine Chassis
318—Midget Shoe-type Brake
324—Stainless, Low-torque Retainer
331—Spring-set, Solenoid Relaxed Brake for 40 Frame Motors

MECHANICAL PARTS

305—Self-conforming Polymer Seal
312—Cellular-sponge Sealing Grommet
322—Stock Knobs Are Molded
323—Pressure-sensitive Nameplates
324—Stainless, Low-torque Retainer
325—Multipurpose Indexing Conveyor
329—15-in.-dia Rotary Table
332—Tread-lock Brake

FASTENING AND JOINING

302—Self-locking Capscrew
303—Adjustable-diameter Bolts
317—Continuous-threaded Studs

MOTORS, ENGINES AND CONTROLS

304—Bidirectional Stepping Motor
309—Static Adjustable-speed Drive
310—Turret Indexing-machine Chassis
320—Fan-cooled Induction Motor

ELECTRICAL, ELECTRONIC COMPONENTS

300—Ultrasonic Sensing and Switching System
301—Modular Rotary Switches
311—Single-circuit Contact Block
313—Decade Tubes Count
314—Lighted Pushbutton Switch
316—Silicon Tunnel Diodes
326—Connector for Terminal Strips
327—Low-cost Power Relay
328—Magnetic Reed Switch
330—Digital Counters and Timers

HYDRAULIC, PNEUMATIC EQUIPMENT

305—Self-conforming Polymer Seal
306—Six Industrial Valves
308—Automatic Seal Rotary Union
315—Miniature Relief Valve
321—Ultrahigh Vacuum Couplings

MECHANICAL PARTS

350—Conveyors, Casters and Wheels, 44 pp, Rapids-Standard Co Inc.
353—Continuously Generated Cams, 5 pp, Stelron Cam Co.
357—Mechanical Shaft Seals, 8 pp, Muskegon Piston Ring Co, Rotary Seal Div.
362—Vibration Isolator, 2 pp, Barry Controls Inc.

ELECTRICAL, ELECTRONIC COMPONENTS

359—Infrared Components, 8 pp, John J Fannon Products Co.
360—Telephone Type Relays, 4 pp, American Machine & Foundry Co.
364—Medium Voltage Dc Power Supplies, 2 pp, Opad Electric Co.

HYDRAULIC, PNEUMATIC EQUIPMENT

361—Canned Pumps, 4 pp, Goulds Pumps Inc.

(please print or type)

Name..... Title.....

Street.....

City..... Zone..... State.....

Company..... Major Product Manufactured.....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS
P38 P40 P41 P45 P46 P49 P50 P51 P52
P53 P54 P55 P56 P57 P58 P59 P60 P61

*MULTIPLE Key No.	PRODUCT ADS Specific Product

(please print or type)

Name..... Title.....

Street.....

City..... Zone..... State.....

Company..... Major Product Manufactured.....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS
P38 P40 P41 P45 P46 P49 P50 P51 P52
P53 P54 P55 P56 P57 P58 P59 P60 P61

*MULTIPLE Key No.	PRODUCT ADS Specific Product

USE THESE PREPAID CARDS FOR

- More information on advertised products
- More data on new materials and components
- Copies of catalogs and bulletins offered
- Free editorial reprints
- Your personal subscription to PRODUCT ENGINEERING

Issue of September 19, 1960
PRODUCT ENGINEERING
Card Expires November 18, 1960

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING
330 WEST 42nd STREET
NEW YORK 36, N. Y.

22 FL

Issue of September 19, 1960
PRODUCT ENGINEERING
Card Expires November 18, 1960

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By Reader Service Department

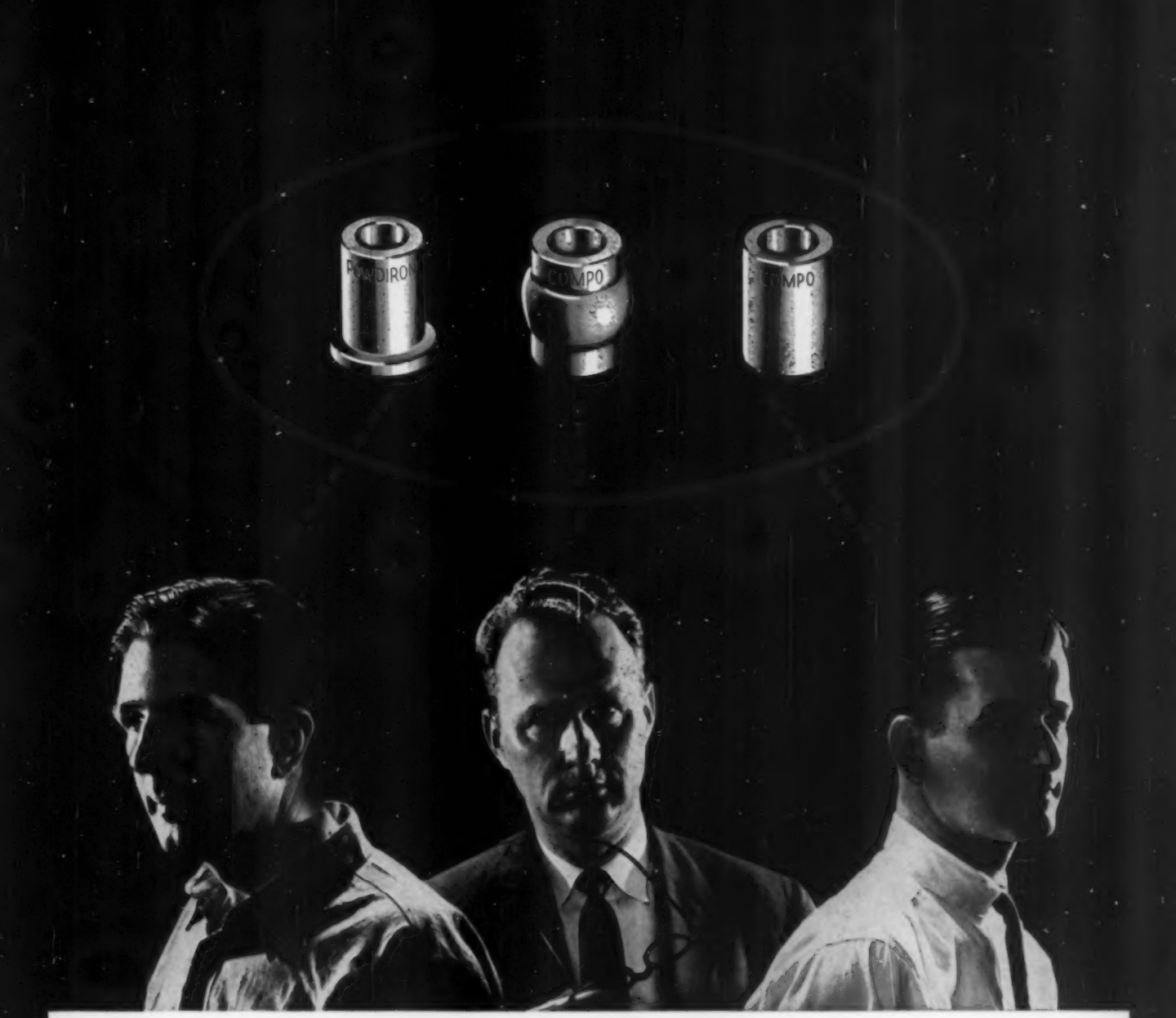
PRODUCT ENGINEERING
330 WEST 42nd STREET
NEW YORK 36, N. Y.

22 FL

Information Sent Promptly

An Opportunity To Get More Information Quickly, Conveniently

Circle 202 Reader Service Card →



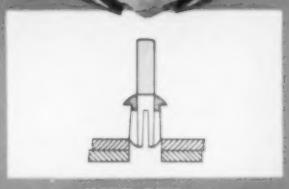
Specialization in bearings enables us to apply to your bearing problems an unmatched engineering talent and experience in powder metallurgy. You benefit, too, from outstanding manufacturing facilities, including the world's largest inventory of dies. Whatever your need, when it's bearings, see the bearing specialists... see Bound Brook.

BOUND BROOK

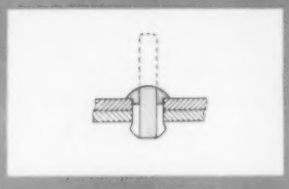
Bound Brook Oil-less Bearing Co., Bound Brook, N. J.
Pioneer in Powder Metallurgy Bearings and Parts.
Plants at Bound Brook, N.J. and Sturgis, Mich.

time-saving, neat-appearing **FASTEX®**

Plasti-Rivets®

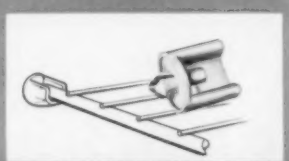


JUST SET . . .



. . . AND DRIVE

Plasti-Rivets fasten molding onto coin-operated machines, are available in colors to complement product color scheme.



The Plasti Rivet principle has been incorporated in Plasti-Supports (TM); form ideal refrigerator shelf-supports.

Molded of thermoplastics, Plasti-Rivets fasten from one side with a single blow. The prongs expand when the integrally molded pin is driven, providing a positive, vibration resistant lock. Blind assembly is simplified, products improved and time saved while costs are reduced. Plasti-Rivets can withstand a direct shear of up to 500 pounds. Available in a choice of decorator colors and shapes, Plasti-Rivets will never mar or scratch your product's surface. For a firm, positive fastening, specify easy-to-use Fastex Plasti-Rivets.

Write for your free sample packet and informative brochure listing 25 standard Plasti-Rivets. See how simple and economical blind fastening can be.

Fastex Plasti-Rivets Create Assembly Savings in: non-conductive fastening of electrical products, name plate attachments, appliance shelf fastening, rustproof fiberglass awning fastening, and color-matched fastenings for practically any product.

FASTEX / **DIVISION OF ILLINOIS TOOL WORKS**
195 Algonquin Road • Des Plaines, Illinois

In Canada:
SHAKEPROOF-FASTEX
Division of Canada
Illinois Tools, Ltd.
Toronto, Ontario

itw